Department of Geophysical Technology

1.	MAN-001	Mathematics-1	BSC	4
2.	PHN-001	Mechanics	BSC	4
3.	CEN-105	Introduction to Environmental Studies	GSC	3
4.	HSN-001A	Communication Skills (Basic)	HSSC	2
5.	HSN-001B	Communication Skills (Advance)	HSSC	2
6.	HSN-002	Ethics and General Awareness	HSSC	2
7.	ESN-101	Introduction to Earth Sciences	DCC	2
8.	ESN-103	Computer Programming	ESC	4
9.	MAN-006	Probability and Statistics	BSC	4
10.	PHN-008	Electromagnetic Theory	BSC	4
11.	ESN-102	Physical Geology	DCC	4
12.	ESN-104	Crystallography and Mineralogy	DCC	4
13.	HYN-102	Engineering Hydrology	ESC	4
14.	EEN-112	Electrical Science	ESC	4
15.	ECN-102	Physical Geology	DCC	4
16.	ESN-201	Basic Petrology	DCC	4
17.	ESN-202	Sedimentology	DCC	4
18.	ESN-203	Paleontology	DCC	4
19.	ESN-204	Stratigraphy	DCC	4
20.	ESN-205	Structural Geology-I	DCC	4
21.	ESN-206	Igneous Petrology	DCC	4
22.	ESN-221	Field Theory	DCC	4
23.	ESN-222	Geology of India	DCC	4
24.	ESN-223	Geophysical Prospecting	DCC	3
25.	ESN-224	Geophysical Signal Processing	DCC	4
26.	ESN-301	Structural Geology-II	DCC	4
27.	ESN-302	Mineral Exploration	DCC	4

28.	ESN-303	Metamorphic Petrology	DCC	4
29.	ESN-304	Ore Geology	DCC	4
30.	ESN-305	Economic Geology	DCC	4
31.	ESN-306	Geomorphology	DCC	3
32.	ESN-321	Gravity and Magnetic Prospecting	DCC	4
33.	ESN-322	Electromagnetic Prospecting	DCC	4
34.	ESN-323	Electrical Prospecting	DCC	4
35.	ESN-324	Seismic Prospecting	DCC	4
36.	ESN-325	Seismology	DCC	4
37.	ESN-341	Himalayan Geology	DEC	4
38.	ESN-342	Advanced Stratigraphy and Facies Modelling	DEC	4
39.	ESN-343	Carbonate Sedimentology	DEC	4
40.	ESN-344	Basin Analysis	DEC	4
41.	ESN-345	Rock and Soil Mechanics	DEC	4
42.	ESN-346	Applied Geochemistry	DEC	4
43.	ESN-372	Geomagnetism	DEC	4
44.	ESN-374	Marine Geophysics	DEC	4
45.	ESN-401	Principles of Remote Sensing	DCC	3
46.	ESN-402	Geophysical Prospecting	DCC	4
47.	ESN-403	Principles of Geographic Information Systems	DCC	3
48.	ESN-404	Well Logging	DCC	4
49.	ESN-405	Hydrogeology	DCC	3
50.	ESN-406	Plate Tectonics	DCC	3
51.	ESN-407	Engineering Geology	DCC	3
52.	ESN-409	Petroleum Geology	DCC	3
53.	ESN-421	Numerical Modelling in Geophysics	DCC	4
54.	ESN-422	Geophysical Inversion	DCC	4
55.	ESN-423	Geophysical Well Logging	DCC	4
56.	ESN-424	Petroleum Geosciences	DCC	4

57.	ESN-442	Mineral Economics	DEC	4
58.	ESN-444	Indian Mineral Deposits	DEC	4
59.	ESN-446	Precambrian Tectonics	DEC	4
60.	ESN-448	Advanced Remote Sensing	DEC	4
61.	ESN-450	Advanced Geographic Information Systems	DEC	4
62.	ESN-452	Advanced Engineering Geology	DEC	4
63.	ESN-454	Marine Geology	DEC	4
64.	ESN-471	Geotechnical Investigations	DEC	4
65.	ESN-472	Advanced Seismology	DEC	4
66.	ESN-473	Magnetotellurics and Geomagnetic depth sounding	DEC	4
67.	ESN-474	Advanced Electromagnetic prospecting	DEC	4
68.	ESN-475	Digital Image Processing	DEC	4
69.	ESN-476	Synthetic Seismogram	DEC	4
70.	ESN-477	Strong Motion Seismology	DEC	4
71.	ESN-478	Environmental and Engineering Geophysics	DEC	4
72.	ESN-545	Mineral Technology	DEC	4
73.	ESN-547	Isotope Geology	DEC	4
74.	ESN-549	Coal Geology	DEC	4
75.	ESN-551	Micropaleontology and Paleoceanography	DEC	4
76.	ESN-553	Global Environment	DEC	4
77.	ESN-555	Shear Zone Metasomatism	DEC	4
78.	ESN-557	Theory and application of Mohr Circle	DEC	4
79.	ESN-559	Advance stress and strain analysis	DEC	4
80.	ESN-561	Quaternary Geosciences	DEC	4
81.	ESN-563	Fluid Inclusions: Methods & Applications	DEC	4
82.	ESN-565	Structural Geology for Petroleum Exploration	DEC	4
83.	ESN-571	Reservoir Geophysics	DEC	4
84.	ESN-573	Geotomography	DEC	4
85.	ESN-575	Geophysical Fluid Dynamics	DEC	4

86.	ESN-577	Advanced Techniques in Geophysical Exploration	DEC	4
87.	ESN-579	Dynamic Systems in Earth Sciences	DEC	4
88.	ESN-581	Advanced Seismic Prospecting	DEC	4

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-008** Course Title: **General Chemistry-III**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits: **4** 6. Semester**: Spring** 7. Subject Area**: BSC**

8. Pre-requisite: **Nil**

9. Objective: To impart basic knowledge of chemistry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Thermodynamics*:*** Statistical concept of entropy, description of equilibrium and feasibility of chemical reactions, Clausius-Clapeyron equation, partial molar quantities-chemical potential, ionic activity coefficients.	**4**
2.	**Kinetics:** Theories of chemical reactions – Draw-backs of collision theory, transition state theory using partition functions and its thermodynamic formulation, consecutive and parallel reactions.	**4**
3.	**Photochemistry**: Basics of photochemistry, photochemical reactions in aqueous medium and environment, free radicals as reactive intermediates, their methods of preparation and use in synthesis, CFCs and alternatives to CFCs.	**4**
4.	**Chemistry of Natural Water:** Speciation of acids and bases, pC-pH diagrams and their applications, redox potentials − their uses in chemical speciations, acid-base and redox chemistry of compounds of sulphur, nitrogen and phosphorus including their environmental implications. Heavy metals (Pb, Hg and As) and their speciation causing toxicity.	**7**
5.	**Corrosion:** Corrosion processes in metals – electrochemical aspects, prevention strategies for corrosion.	**2**
6.	**Cement C hemistry:** Cement− its constituents and their structures, classification of cement, hydration process and importance of the products of hydration, chemistry of pozzolanic reactions. Analysis of Portland cement with reference to insoluble residue, total silica, sesquioxides, iron, lime and manganese. Role of calcium hydroxide in cement.	**7**
7.	**Soil C hemistry:** Chemical composition of soils, types of clay minerals, soil colloids, diffused double layers, sorption processes, cation and base exchange phenomenon in soils, isomorphous substitution.	**5**

8.	**Petroleum C hemistry:** Overview of petroleum processing − fractional distillation, gasoline/petrol − classification, knocking, octane number.	**3**
9.	**Spectral T echniques**: Introduction of spectroscopic techniques viz., UV-Vis, IR, and Mass spectroscopy for structural prediction of organic compounds.	**6**
	Total	**42**

List of Experiments:

i)	Determination of sodium carbonate in baking/washing soda.
ii)	Determination of Zn by EDTA- complexometric titration.
iii)	Determination of nitrogen as ammonia in a sample.
iv)	Determination of viscosity of a polymer in a solution /or in a mixture of liquid.
v)	Determination of surface excess concentration of 1-butanol in aqueous solution.
vi)	Kinetics of a reaction between hydrogen peroxide and iodine in acidic medium.
vii)	Photochemical reduction of ferric oxalate in cyanotype blue printing.
viii)	Spectrophotometric determination of [Fe (III)] by using KSCN.
ix)	Identification of functional groups in an organic compound.
x)	Characterization of an organic/inorganic compound by UV-Vis and IR spectra.
xi)	Sectrophotometric determination of λ_{max} and concentration of $KMnO_4/K_2Cr_2O_7$.
xii)	pH metry/ potentiometry titration: strong acid – strong base.
xiii)	Preparation of potash alum from scrap aluminium.
xiv)	Synthesis of potassium trisoxalatochromate(III).

11. Suggested Books:

S. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Atkins, P.W., "Physical Chemistry", 8th Ed., Oxford University Press.	2006
2.	Turro, N.J., Ramamurthy, V. and Scaiano, J.C., "Modern Molecular Photochemistry of Organic Molecules", University Science Books.	2008
3.	Manahan, S.E., "Environmental Chemistry", 8th Edition, CRC Press.	2005
4.	Masters, G.M. and Ela, W.P., "Introduction to Environmental Engineering and Science", 3rd Ed., Pearson Education.	2008
5.	Taylor, H.F.W., Cement Chemistry, 2nd Ed. (reprinted), Thomas Telford Services Ltd., London.	2004
6.	Morrison, R.T., Boyd, R.N. and Bhattacharjee, S.K., "Organic Chemistry", 7th Ed., Pearson Education in South Asia.	2013
7.	Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Pearson Education Asia.	2009
8.	Sposito, G., "Chemistry of Soils", 2nd Ed., Oxford University Press.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **DEPARTMENT OF CIVIL ENGINEERING**

1. Subject code: **CEN-105** Course Title: **Introduction to Environmental Science**
2. Contact Hours: **L: 3 T: 0 P: 0**
3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0
4. Relative Weightage: **CWS:** 15 **PRS:** 0 **MTE:** 35 **ETE:** 50 **PRE:** 0
5. Credits: 3 6. Semester: **Autumn** 7. Subject Area: **GSC**
8. Pre-requisite: **Nil**
9. Objective: To introduce fundamentals of environmental pollution and its control.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview: Environment and Natural Processes; Development (Resource Utilization & Waste Generation); Environmental issues; Concept of Sustainable Development; Issues affecting future development (population, urbanization, health, water scarcity, energy, climate change, toxic chemicals, finite resources etc.); Environmental units	6
2.	Air –Water interaction: (Liquid phase-gas phase equilibrium) Henry's Law Constant with units, Dimensionless Henry's Law Constant	3
3.	Water –Soil Interaction: Carbonate System (Alkalinity and buffering capacity); Major ions in water; Natural Organic Matter (NOMs); Water quality parameters; Physical processes (Mass Balance): Spatio-temporal variation in quality of river water, lake water, ground water; Water quality standards	9
4.	Wetlands, water treatment and wastewater treatment .	6
5.	Air resources: Atmosphere; Air pollutants; Emissions and control of air pollutants; Atmospheric meteorology and dispersion; Transport of air (global, regional, local); Air/ atmospheric stability; Plume shape; Gaussian modeling; Air quality standards	9
6.	Land pollution and solid waste management	3
7.	Ecosystem: Structure and function; Energy flow in ecosystem; Material flow in ecosystem; Biodiversity and ecosystem health; Bio-amplification and bio-magnification	3
8.	Hazardous Waste: Definition; Classification; Storage and management; Site remediation; Environmental Risk: assessment, and management	3
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davis M. L. and Cornwell D. A., "Introduction to Environmental Engineering", McGraw Hill, New York 4/e	2008
2.	Masters G. M., Joseph K. and Nagendran R. "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi. 2/e	2007
3.	Peavy H. S., Rowe D.R. and Tchobanoglous G., "Environmental Engineering", McGraw Hill, New York	1986
4.	Mines R. O. and Lackey L. W. ""Introduction to Environmental Engineering", Prentice Hall, New Yark	2009
5.	Miheicic J. R. and Zimmerman J. B. " Environmental Engineering: Fundamentals, Sustainability, Design" John Wiley and Sons, Inc.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electronics and Communication Engineering**

1. Subject Code: **ECN-102** Course Title: **Fundamentals of Electronics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: ESC**

8. Pre-requisite**: Nil**

9. Objective: To impart knowledge of basic principles of electronics to UG students from other disciplines of engineering and science.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of properties of metals, dielectrics and semiconductors.	**1**
2.	**Diodes**: Working principle and characteristics and diode applications (rectification with capacitive filter and zener regulation).	**4**
3.	**BJT**: Operation and characteristics, brief overview of DC biasing, 're' model, Amplifier (CE, CB and CC).	**6**
4.	**MOSFET**: Introduction to MOSFET operation and characteristics.	**1**
5.	**Operational Amplifiers**: Input modes and parameters, introduction to concept of negative feedback, negative feedback in OPAMP, bias currents and offsets, open and closed loop responses.	**5**
6.	**Op-Amp A pplications**: Comparator, summing, integrator, differentiator, instrumentation amplifiers, isolation amplifiers, Operational Transconductance Amplifiers, Log and Antilog amplifiers, Converters, Introduction to OPAMP based active filters, Brief description of OPAMP based oscillators.	**8**
7.	**Basic D igital E lectronics**: Binary number system, Boolean algebra, Logic gates, adders, one-bit memory, flip-flops (SR, JK), shift registers, Asynchronous counter.	**8**
8.	**Introduction t o microprocessor**: Four-bit microprocessor architecture, stored program computer, instruction set and basic assembly language programming.	**9**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson, 10th Edition.	2009
2.	Floyd T.L., Buchla D.L., "Electronics Fundamentals: Circuits, Devices and Applications", 8th Edition	2010
3.	Millman J., Halkias C.C., Jit S., "Electronic Devices and Circuits", Tata McGraw-Hill, 2nd Edition.	2007
4.	Dorf R.C., Smith R.J., "Circuits, Devices and Systems: A First Course in Electrical Engineering", 5th Edition	1991

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-112** Course Title: **Electrical Science**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: ESC**

8. Pre-requisite**: NIL**

9. Objective: To introduce the students to the fundamentals of Electrical Engineering concepts of network analysis, principles of electrical machines, basics of electrical measurement and measuring instruments.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Energy Resources an d U tilization:** Conventional and non-conventional energy resources; Introduction to electrical energy generation from different resources, transmission, distribution and utilization.	**5**
2.	**Network F undamentals**: Types of Sources and elements, Kirchoff's Laws, Mesh and Node Analysis of D.C. Networks, Network Theorems: Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum Power Theorem, Star-Delta Transformation.	**5**
3.	**A.C. F undamentals**: Concept of phasor, impedance and admittance; Mesh and Node analysis of AC networks; Network theorems in AC networks; Active and reactive power in AC circuits; Resonance in series AC circuits; Power factor correction.	**4**
4.	**Three-phase A.C . Circuits**: Analysis of 3-phase balanced start-delta circuits, Power in 3-phase Circuits.	**2**
5.	**Measurement of E lectrical Qu antities**: Measurement of Voltage, Current, and Power; Measurement of 3 phase power; Energy meters.	**5**
6.	**Single P hase T ransformer**: Introduction to magnetic circuit concepts, Basic constructional features, operating principle, phasor diagram, equivalent circuit, voltage regulation; Eddy current and Hysteresis losses, efficiency; Open circuit and Short Circuit tests.	**5**

7.	**D.C. Machines**: Principle of operation, constructional features; Emf and torque equations; Types of excitation; Generator characteristics; Starting and speed control of D.C. motors.	**5**
8.	**AC Machines**: Three-phase Induction Motor - Operating principle, constructional features, torque-speed characteristics, starting and speed control; Single-phase Induction Motor - Operating principle, constructional features, torque-speed characteristics, starting methods.	**5**
9.	**Industrial A pplications an d C ontrol: V** arious industrial loads, traction, heating, lighting; Concept of power electronic control of AC and DC motors.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Mukhopadhyaya P., Pant A.K., Kumar V. and Chittore D.S., "Elements of Electrical Science", M/s Nem Chand & Brothers.	1997
2.	Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India.	2002
3.	Dubey G. K., "Fundamentals of Electric Drives", 2nd Ed., Narosa Publishing House.	2007
4.	Alexander C.K., Sadiku M.N.O., "Fundamentals of Electric Circuits", McGraw Hill, 5th Edition.	2012
5.	Chapman, Stephen, J., "Electric Machinery Fundamentals", McGraw Hill Book Company.	1985
6.	Hughes Edward, "Electrical & Electronic Technology", Pearson Publishing, 8th edition.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-101** Course Title: **Introduction to Earth Sciences**

2. Contact Hours: **L: 2** **T: 0** **P: 0**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **-** **MTE** **35** **ETE** **50** **PRE** **-**

5. Credits**:** **2** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**:** **Nil**

9. Objective: To introduce basic concepts of various branches of Earth Sciences.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Earth, its place in Solar System, Plate tectonics: Concept of Earth as a dynamic planet, physical features of its surface, other basic features and Earth's interior, Geological divisions of India	**6**
2.	Evolution of the Earth through ages and study of development of life on Earth (Paleontology)	**2**
3.	Study of Earth composition and deformation: Mineralogy and Petrology	**3**
4.	Study of rock deformation: Structural Geology	**3**
5.	Geoexploration methods for finding natural resources like groundwater, hydrocarbons, coal and minerals: Geophysics, remote sensing and other geological methods.	**10**
6.	Natural hazards: Volcanoes, earthquakes and Tsunami, glaciers, landslides, mudflows and avalanches and their study using geophysical methods, remote sensing, GIS and GPS	**4**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Press F. and Siever R., "Understanding the Earth", W.H. Freeman & Co.	**2000**
2.	Parriaux A., "Geology: Basics for Engineers", CRC Press, T&F Group	**2009**
3.	Moore J. S. and Wicander R., " Physical Geology", Brooks/Cole Pacific Grove ,CA	**2001**
4.	Lowrie W., " Fundamentals of Geophysics", Cambridge University Press	**2007**
5.	Marshak S., "Essentials of Geology", W.W. Norton & Company	**2004**
6.	Huddart D. and Stott T., "Earth Environments: Past, Present and Future, Wiley-Blackwell	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-102** Course Title: **Physical Geology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**

4. Relative Weightage**: CWS: 25 PRS: 0 MTE : 25 ETE: 50 PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide basic knowledge about the Earth, and its internal and external processes.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Earth as a planet; its origin and age	3
2.	Earth's internal structure and composition	3
3.	Variation of temperature, pressure, density from surface to center of the Earth	3
4.	Theory of Isostasy and its significance in distribution of land and ocean	3
5.	Continental drift and sea floor spreading	2
6.	Plate tectonics and different types of plate boundaries; major plates of the world	4
7.	Earthquakes, origin, distribution, cause and results; seismic waves and their implications	3
8.	Volcanoes and related physical features	2
9.	Orogenic belts of the world	2
10.	Folds, faults and unconformities	4
11.	Weathering, erosion and deposition	3
12.	Types of mass movement: causes, patterns and remedies	2
13.	Rock and water cycles	3
14.	Overview of natural disasters	3
	Total	**42**

11. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication/ Reprint
1.	Reed WicanderJames S. Monroe "Essentials of Physical Geology" Cengage Learning, USA	2009
2.	James S. MonroeReed Wicander andRichard W. Hazlett "Physical Geology: Exploring the Earth" Thomson Higher Education, USA	2007

3.	Marshak, S., “Essentials of Geology”, John Wiley & Sons, USA	2004
4.	Chernicoff, S., Fox, H.A. and Tanner, L.H., “Earth: Geologic Principles and Histories”, Cengage Learning, USA	2002
5.	Press, F. and Siever, R., “Understanding the Earth”, W. H. Freeman, USA	2000
6.	Holmes, A., “Principles of Physical Geology”, Chapman & Hall, UK	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT:**DEPARTMENT OF EARTH SCIENCES**

1. Subject Code: **ESN-103** Course: **Computer Programming**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **0** **0**
4. Relative Weightage: **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **00**
5. Credits : **0** **4**
6. Semester: **Autumn**
7. Pre-requisite: **Nil**
8. Subject Area: **ESC**

9. Objective: To introduce Computer Systems and develop basic skills in programming.

11. Details of the Course:

S. No	Contents	Contact Hours
1	**Basic Computer Fundamentals:** Introduction to computer systems; number system, integer, signed integer, fixed and floating point representations; IEEE standards integer and floating point arithmetic; CPU organization, ALU, registers, memory, the idea of program execution at micro level; concept of flow chart and algorithms, algorithms to programs.	**7**
2	**Basic Programming and Aspects of C++: Input/Output:** Constants, variables, expressions and operations; Naming conventions and styles; Conditions and selection statements; Looping and control structures; File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking.	**8**
3	**Programming Through Functional Decomposition:** Functions (void and value returning), parameters, scope and lifetime of variables, passing by value, passing by reference, passing by constant reference; Design of functions and their interfaces (concept of functional decomposition), recursive functions, function overloading and default arguments; Library functions.	**8**
4	**Aggregate Data-types:** Arrays and Pointers, structures, dynamic data and pointers, dynamic arrays; Introduction to data structures, use of pointers in linked structures.	**7**
5	**Object Oriented Programming:** Data hiding, abstract data types, classes, access control; Class implementation – default constructor, constructors, copy constructor, destructor, operator overloading, friend function; Object oriented design, inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.	**12**
	Total	**42**

10. Suggested Books:

S. No	Name of Books/ Authors	Year of Publication
1	Dietel, H.M. and Dietel, P.J., “C++ How to Program”, Prentice Hall.	2004
2	Nell Date, Chip Weema and Mark Headington, “Programming and Problem Solving with C++”, CBS Publishers and Distribution.	2000
3	Cohoon, J.P. and Davidson, J.W., “C++ Program Design”, Tata McGraw Hill.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-104** Course Title: **Crystallography and Mineralogy**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory : 3** **Practical : 2**

4. Relative Weightage**:** **CWS: 15** **PRS: 15** **MTE: 15** **ETE : 40** **PRE: 15**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide basic knowledge of crystals, crystal systems and minerals.

10. Details of Course:

S.No.	Contents	Contact Hours
1	Classification of crystal systems, Miller indices and crystal forms	4
2	Crystal defects, polymorphism, isomorphism, pseudomorphism, exsolution and twinning	5
3	Silicate mineralogy	6
4	Carbonates, sulphates, oxides and other mineral groups: their chemistry and crystal structures	5
5	Genesis, distribution, occurrence and association of different mineral groups in rocks	5
6	Introduction to ore minerals	2
7	Physical properties of different minerals	5
8	Introduction to optical microscopy; isometric minerals, uniaxial and biaxial minerals, optic figures, optical properties of minerals	6
9	X-ray diffraction; theory, Bragg's law, instrumentation	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication/ Reprint
1.	Clein, C. and Dutrow, B., "23rd Edition of the Manual of Mineral Science", Willey, J. & Sons	2008
2.	Dexter, P. and Henke, K.R.,"Minerals in Thin Section", Pearson/Prentice Hall	2004
3.	Perkins, D., "Mineralogy", Prentice Hall PTR	2002
4.	Nesse, W., " Introduction to Mineralogy", Oxford University Press	2000
5.	Deer, W.A., Howie, R.A. and Zussman, J., "An Introduction to the Rock-Forming Minerals", ELBS	1996
6.	Nesse, W.D., "Introduction to Optical Mineralogy", Oxford University Press	1991

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-201** Course Title: **Basic Petrology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To impart basic knowledge of rocks, their origin, types, textures and structures.

10. Details of Course:

Sl.No.	Contents	Contact Hours
1.	Fundamental concepts in Igneous Petrology	**2**
2.	Concepts of magma, fractional crystallization, liquid immiscibility, magma mixing and assimilation	**8**
3.	Classification of igneous rocks	**3**
4.	Classification and formation of sedimentary rocks	**6**
5.	Texture and structures of different types of sedimentary rocks	**4**
6.	Petrological characteristics of sedimentary rocks	**5**
7.	Types of metamorphism, agents of metamorphism	**4**
8.	Metamorphic textures and structures	**3**
9.	Concept of metamorphic facies and grade	**4**
10.	Classification of metamorphic rocks	**3**
	Total	**42**

List of Practicals

1. Megascopic study of different rock types.
2. Microscopic study of common igneous, metamorphic and sedimentary rocks

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Winter, J.D., "*Principles of Igneous and Metamorphic Petrology*", Prentice Hall	2009
2.	Boggs, S. Jr., "*Petrology of Sedimentary Rocks*", Cambridge University Press	2009
3.	Vernon, R.H and Clarke, G., "*Principles of Metamorphic Petrology*", Cambridge University Press	2008
4.	Dexter, P. and Henke, K.R., "*Minerals in Thin Section*", Pearson/Prentice Hall	2004
5.	Raymond, L. A., "*Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks*", McGraw Hill College	2001
6.	Pettijohn, F.J., "*Sedimentary Rocks*", Harper Collins	1983

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-202** Course Title: **Sedimentology**

2. Contact hours: **L: 3** **T: 0** **P: 2**

3. Examination duration (hrs): **Theory: 3** **Practical: 0**

4. Relative weightage: **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits : **4** 6**.** Semester: **Spring** 7. Subject Area: **DCC**

8. Pre-requisite: **Nil**

9. **Objective:** To provide in-depth knowledge of sedimentary textures and structures and sedimentary processes including depositional environments

10. **Details of course:**

Sl. No.	Contents	Contact hours
1.	Introduction- overview of sedimentology, weathering and erosion under different climatic conditions	**3**
2.	Transportation of sediments: simple fluid flow concepts	**3**
3.	Mass properties of sediments	**2**
4.	Sedimentary structures- classification, genesis, use of textures and structures in sediment dispersal and basin studies	**4**
5.	Textures of clastic and non-clastic rocks	**3**
6.	Paleocurrent analysis and its importance in provenance	**2**
7.	Composition and classification of different types of sedimentary rocks and their genetic importance	**6**
8.	Diagenesis - compaction, cementation, authigenesis, metasomatic replacement, role of Eh-pH, stages in diagenesis of clastic rocks	**4**
9.	Clay minerals- classification, and x-ray diffraction identification, environmental interpretation and diagenesis	**3**
10.	Depositional environments - classification, processes and products	**5**
11.	Sedimentation and Tectonics- Review of concept of geosynclines and plate-margins, major types of basins and distribution of environments and lithofacies within basins, evolution of basins with time	**4**
12.	Analysis of coal and petroleum basins	**3**
	TOTAL	**42**

List of Practicals:

1. Analysis of roundness, grain size and sphericity
2. Megascopic study of common sedimentary structures
3. Vectorial analysis of paleocurrent data from individual outcrops and analysis of spatial paleocurrent data by moving average method
4. Study of thin sections of common sedimentary rocks
5. Determination of facies cyclothems from a vertical log
6. Analysis and identification of clay minerals

11. **Suggested Books:**

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Boggs, Sam (Jr.): *Petrology of Sedimentary Rocks, 2nd Ed*. Cambridge.	2009
2.	Nichols, G.: *Sedimentology and Stratigraphy*, 2nd Ed. Wiley-Blacwell	2009
3.	Boggs, Sam (Jr.): *Principles of Sedimentology and Stratigraphy, 4th Ed*. Pearson/Prentice Hall.	2006
4.	Allen, P.A. and Allen, J.R.: *Basin Analysis: Principles and Applications*. Blackwell publishing	2005
5.	Prothero, D.R. and Schwab, F.: *Sedimentary Geology, 2nd edition*. Freeman.	2003
6.	Reading, H.G.: *Sedimentary Environments and Facies*. 6th Ed., Blackwell Scientific Publ., Oxford.	1996
7.	Tucker, M.E.: *Sedimentary Petrology- An Introduction*. Blackwell Scientific Publ., Oxford	1981

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-203** Course Title: **Paleontology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To introduce basic concepts in Paleontology including invertebrate, vertebrate and plant fossils and evolution of life through ages

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Fundamentals:** Definition, objectives and scope, nature of fossil record and their uses, the organic world, classification of animals, their habits and habitats, evolution of life through the ages, migration, dispersal and extinction of life	**9**
2.	**Invertebrate Paleontology**: Morphology, classification, evolutionary trends, geological history and geographical distribution of brachiopoda, pelecypods, gastropods, cephalopoda, trilobita, echinoidea, coelenterates and graptolodiea	**9**
3.	**Vertebrate Paleontology:** Introduction , broad classification and study of vertebrate groups	**6**
4.	**Paleobotany:** Introduction, Gondwana flora and their applications	**4**
5.	**Micropaleontology:** Introduction, techniques of processing of samples, brief morphology and classification of foraminifers, ostracods, radiolarians and conodonts	**6**
6.	**Applied Aspects**: Age determination and correlation, paleoecological interpretations with case histories, fossils as a tool in petroleum exploration	**8**
	Total	**42**

List of Practicals:

1. Megascopic study of invertebrate, vertebrate and plant fossils
2. Microscopic study of invertebrate and vertebrate fossils

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	McGowran, B., "Biostratigraphy: Microfossils & Geological Time", Cambridge University Press	2005
2.	Milsom, C., and Rigby, S., "Fossils at a Glance", Blackwell	2004
3.	Benton, M.J., "Vertebrate Paleontology", Chapman & Hall	1997
4.	Colbert, R.L., "Paleontology", John Willey & Sons	1987
5.	Woods, H., "Paleontology Invertebrate", CBS Publications	1963
6.	Walton, J., "An Introduction to the Study of Fossil Plants", Adam & Charles Black	1953

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-204** Course Title: **Stratigraphy**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide basic understanding of geological time scale, principles of stratigraphy, stratigraphic sequences of India and boundary problems

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Definition and scope of stratigraphy	**4**
2.	Principles of superposition, original horizontality and uniformitarianism	**2**
3.	Geological time scale, purpose, scope and development	**6**
4.	Stratigraphic classification and nomenclature of units, lithostratigraphy, biostratigraphy, chronostratigraphy and geochronology	**8**
5.	Stratigraphic contacts, conformity and unconformity	**2**
6.	Definition, scope and types of correlation	**2**
7.	Introduction to facies, transgression and regression	**4**
8.	Major Precambrian and Phanerozoic stratigraphic sequences of India	**8**
9.	Major stratigraphic boundary problems	**6**
	Total	**42**

List of Practicals:

1. Study of rock samples in hand specimen from various stratigraphic horizons/sequences of India in terms of their characteristic feature, associated fossils and their arrangements in stratigraphic order.

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Ramakrishnan, M. and Vaidyanathan, R., "Geology of India", Vol. I and II, Geological Society of India	2008
2.	Lemon, R.L., "Principles of Stratigraphy", Meril Publishing	1990
3.	Boggs, S., Jr., "Principles of Sedimentology and Stratigraphy", Meril Publishing	1987
4.	Kumar, R., "Fundamentals of Historical Geology and Stratigraphy of India", Wiley	1985
5.	Krishnan, M.S., "Geology of India and Burma", CBS Publications	1985
6.	Wadia, D.N., "Geology of India", Tata-McGraw-Hill	1975

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-205** Course Title: **Structural Geology-I**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To introduce basic concepts of tectonic structures in rocks

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Primary versus secondary structures	**4**
2.	**Orientation of planar and linear structures:** Strike, dip, plunge and pitch.	**6**
3.	**Topography and Structures:** Contours, stratum contours and outcrop patterns	**4**
4.	**Folds:** Morphology and geometric classifications of folds.	**4**
5.	**Faults:** Geometric and genetic classification of faults and effect of faulting on outcrops. Ductile shear zones	**6**
6.	**Joints:** Geometric and genetic classification of joints	**6**
7.	**Unconformity:** Different types of Unconformities and criteria for distinction between faults and unconformities.	**6**
8.	**Foliation and Lineation:** Different types of foliation and lineation in rocks	**6**
	Total	**42**

List of Practicals:

1. Contour, stratum contour and outcrop patterns.
2. Hand specimen studies of various types of tectonic structures.
3. Dip and strike problems.
4. Completion of outcrop patterns
5. Geological cross sections of maps
6. Dip isogon classification of folds

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Ragan, D. M., "Structural Geology", IVth Edn., Cambridge Universtiy Press, UK.	2009
2.	Ramsay, J. G. and Huber, M. I., ``Techniques of Modern Structural Geology, Vol. 2, Folds and Fractures``, Academic Press, London.	1987
3.	Ramsay, J. G. and Huber, M. I., ``Techniques of Modern Structural Geology, Vol. 1, Strain Analysis``, Academic Press, London.	1983
4.	Hobbs, B. E., Means, W. D. and Williams, P. F.., ``An outline of Structural Geology``. John Wiley and Sons, NY.	1976
5.	Ramsay, J. G., ``Folding and Fracturing of rocks``, Mc-Graw Hills, NY	1967

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-206** Course Title: **Igneous Petrology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide in-depth knowledge of igneous rocks including their geochemical characteristics and petrogenesis.

10. Details of Course:

S.No.	Contents	ContactHours
1	Introduction to Igneous Petrology, Classifications of igneous rocks	**4**
2.	Igneous Textures and Structures	**4**
3.	Phase diagrams	**4**
4.	Processes involving modification of primary magma	**4**
5.	Fractional crystallization and crustal contamination	**4**
6.	Plate Tectonics and Igneous Petrogenesis: Overview	**2**
7.	Magmatism at constructive plate margin, mid-oceanic ridges,	**6**
8.	Magmatism at destructive plate margin, subduction zone magmatism, island arc systems, continental arc magmatism	**8**
9.	Intraplate magmatism, mantle plume, oceanic island	**6**
	Total	**42**

List of Practicals:

1. Microscopic studies of different types of igneous rocks and their petrogenesis
2. Interpretation of various types of geochemical variation diagrams
3. CIPW normative calculations based on geochemical data

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Philpotts, A.R. and Ague, J.J., "*Principles of Igneous and Metamorphic Petrology*" Cambridge University Press	2010
2.	Winter, J., "*An Introduction to Igneous and Metamorphic Petrology*", Prentice-Hall	2001
3.	Hall, A., "*Igneous Petrology*", John Wiley & Sons	1995
4.	Rollinson, H., "*Using geochemical data: evolution, presentation, interpretation*" Pearson Education Limited	1993
5.	Willson, M., "*Igneous Petrogenesis: A Global Tectonic Approach*", Unwin-Hyman	1989
6.	Cox, K.G., Bell., J.D. and Pankhurst, R.J., "*The Interpretation of Igneous Rocks*" George Allen and Unwin Publishers Ltd.	1979

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-221** Course Title: **Field Theory**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory3** **Practical0**

4. Relative Weightage**: CWS25** **PRS0** **MTE25** **ETE50** **PRE0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To introduce fundamentals of potential fields and theory of elasticity.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Concept of Field. Scalar, vector and tensor fields. Gradient, divergence and curl. Gauss divergence theorm, Stokes' theorem and Green's theorem. Classification of fields. Conservative and non-conservative fields.	4
2.	**Partial differential equations governing the fields:** Laplace and Poisson's equation, diffusion equation and wave equation in Cartesian, cylindrical and spherical coordinates, integral equations, Dirichlet's and Neumann's problems.	8
3.	**Potential Field Theory:** Gravitational and magnetic fields. Newton's law of gravitation. Coulomb's law of magnetostatics. Dipole field. Gravitational and magnetic potentials. Multipole expansion of gravitational potential. Gravitational potenial and field of a homogeneous and radially inhomogeneous sphere. Solutions of Laplace equation. Bessel function and Legendre polynomials.	8
4.	**Electrostatics:** Coulomb's law, Ohm's law, equation of continuity, Stefanescu's integral.	2
5.	**Equation of heat conduction:** Diffusion equation, one dimensional heat conduction in a slab.	2
6.	**Wave equation:** Motivation for time-varying fields in geophysics, Wave motion in 2-D and 3-D, vector fields.	4
7.	**Theory of elasticity:** Properties of stress and strain tensors; notions of deviatoric stress and strain; generalized Hooke's law for totally anisotropic media, orthotropic media, transversely isotropic media and isotropic media.	6
8.	**Elastic waves:** Equations of equilibrium for static and dynamic cases, equation of motion for infinitesimal strain, wave equation for elastic media in terms of displacement, Helmholtz equation and wave equation in terms of displacement potentials, solution of wave equation.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Kirkwood, J.R ., "Mathematical Physics with Partial Differential Equations", Academic Press.	2012
2.	Roy,.K.K., "Potential Theory in Applied Geophysics", Springer Verlag.	2008
3.	Lurie, A.I., "Theory of Elasticity", Springer	2005
4.	Sadd, M.H., "Elasticity Theory, Applications, and Numerics", Elsevier	2005
5.	Morse, P.M. and Feshbach, H., "Methods of Theoretical Physics",Vol. I & II, Feshbach Publishing Co.	2004
6.	Blakely, R.J., "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press.	1996
7.	Schwab, A.J., "Field Theory Concepts", Springer-Verlag	1988
8.	Pipes, L.A., "Applied Mathematics for Engineers & Physicists", Mc. Graw Hill.	1970
9.	Landau, L.D. and Lifshitz, E.M., "Theory of Elasticity", Pergamon Press	1970

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE **Department of Earth Sciences**

1. Subject Code: **ESN-222** Course Title: **Geology of India**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide basic understanding of geological time and rock units, principles of stratigraphy, typical stratigraphic sequences in India with special reference to mineralization.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Stratigraphy and its scope in geophysical exploration.	2
2.	Morphotectonic provinces in India	4
3.	Geological Time Scale with special reference to evolution of life	4
4.	Types of geological contacts; interpretation and limitations. scope of stratigraphy in geophysical exploration.	4
5	Concept of metallogenic Epochs and provinces with Indian examples	2
6.	Different types of stratigraphic units and their classification schemes	2
7.	Type areas, stratigraphic equivalents and stratigraphic correlation	4
8.	Geology of the Precambrian sequences and associated mineral deposits	6
9.	Geology of the Paleozoic sequences and associated mineral deposits	4
10.	Geology of the Mesozoic sequences and associated mineral deposits	6
11.	Geology of the Cenozoic sequences and associated mineral deposits	4
	Total	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Valdiya, K. S., ``The making of India: Geodynamic evolution. Macmillan publishers, India.	**2010**
2.	Ramakrishnan, M. and Vaidyanathan, R., "Geology of India", Vol. I and II, Geological Society of India, Bangalore	**2008**
3.	Lemon, R.L., "Principles of Stratigraphy", Meril Publishing	**1990**
4.	Boggs, S., Jr., "Principles of Sedimentology and Stratigraphy", Meril Publishing	**1987**
5.	Kumar, R., "Fundamentals of Historical Geology and Stratigraphy of India", Wiley	**1985**
6.	Krishnan, M.S., "Geology of India and Burma", CBS Publications	**1985**
7.	Wadia, D.N., "Geology of India", Tata-McGraw-Hill	**1975**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN- 223** Course Title**: Geophysical Prospecting**

2. Contact Hours : **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits:4 6. 6. Semester: **Autumn** 7. Subject Area**: DCC**

8. Pre requisite: **Nil**

9. Objective: To introduce basic concepts of geophysical methods and their applications in solving geological problems

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Overview and importance of various geophysical methods in geological studies	**2**
2	**Gravity M ethod:** Basic principles, gravity anomalies, gravimeters, data acquisition procedures, data reduction and processing, interpretation of Bouguer anomalies for basic geometrical shapes, depth rules. Case studies	**8**
3	**Magnetic Method:** Basic principles, magnetic anomalies, magnetometers, data acquisition procedures, data reduction and processing, interpretation of magnetic anomalies for basic geometrical shapes, depth rules. Case studies	**8**
4	**Seismic M ethods:** Refraction, reflection and attenuation of seismic waves, geophones and hydrophones, recording instruments, seismic refraction method, travel time curves for flat and dipping interfaces, interpretation of refraction profiles, seismic reflection method, CDP shooting, geophone grouping, elementary ideas about processing and interpretation of seismic reflection data. Case studies	**10**
5	**Electrical M ethod:** Apparent resistivity, sounding and profiling, different electrode configurations, field procedures, resistivity meters, data interpretation using curve matching method, electrical section. Case studies	**7**
6	**Electromagnetic Me thods:** Basic concepts, dip angle techniques, measurement of amplitude and phase, various transmitter and receiver loop configurations, response curves, airborne electromagnetic method. Case studies	**7**
	Total	**42**

11. Suggested Books:

S.No.	Name of Books/ Authors/Publishers	Year of Publication/ reprints
1.	Lowrie, W., "*Fundamentals of Geophysics*", Cambridge University Press.	2007
2.	Kearey, P., Brooks, M. and Hill, I., "*An Introduction to Geophysical Exploration*", Blackwell.	2002
3.	Telford, W.M., Geldart, L.P. and Sheriff, R.E., "*Applied Geophysics*", Cambridge University Press.	1999
4.	Parasnis, D.S., "*Principles of Applied Geophysics*", Chapman and Hall.	1997
5.	Dobrin, M.B. and Savit, C.H., "*Introduction to Geophysical Prospecting*", McGraw-Hill.	1988
6.	Robinson, E.S., Coruh, C., "*Basic Exploration Geophysics*", John Wiley & Sons.	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-224** Course Title: **Geophysical Signal Processing**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS :25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: Introduction to basic signal processing techniques and their applications in geophysics

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Definitions, properties and classification of signals and systems	**2**
2.	Review of Fourier series; Fourier transform; Laplace transform, and convolution theorem as applicable to geophysical problems; Transfer function formulation, poles, zeroes and their interpretation, minimum phase signals; Hilbert transform, spectral factorization	**12**
3.	Sampling theorem, aliasing, effect of sampling on spectrum, discrete Fourier transform, fast Fourier transform, review of Z-transform, interrelations between Z-transform and discrete Fourier transform	**8**
4.	Stochastic processes, autocorrelation and cross correlation, stationarity, wide-sense stationarity, ergodicity, power spectral density; Applications of Wiener-Khinchin theorem in geophysical problems	**11**
5.	Digital filtering of geophysical data, amplitude and phase response of filters, ideal and realizable low pass, high pass, band pass and notch filters; Wiener filtering, extrapolation, matched filters and routinely used spectral windows in geophysical data processing	**9**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Ingle, V.K. and Proakis, J.G., "*Digital Signal Processing Using MATLAB*"**,** Cengage-Engineering	**2006**
2.	Proakis, J.G. and Dimitris, D.K., "*Digital Signal Processing*", Prentice-Hall	**2006**
3.	Lyons R.G., "*Understanding Digital Signal Processing*", Prentice-Hall	**2004**
4.	Oppenheim, A.V., Schafer. R.W. and Buck, J.R., "*Discrete-Time Signal Processing*", Prentice-Hall	**1999**
5.	Hayes, M.H., "*Schaum's Outline of Digital Signal Processing*", McGraw-Hill	**1998**
6.	Robinson. E.A., and Durrani, T.S., "*Geophysical Signal Processing***",** Prentice-Hall	**1985**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-301** Course Title: **Structural Geology - II**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): Theory**: 3** Practical**: 0**

4. Relative Weightage: **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **DCC**

8. Pre-requisite**:** **ES-205: Structural Geology-I**

9. Objective: To provide in-depth knowledge of techniques of structural analysis for understanding of deformation in rocks

10. Details of Course:

S. No	Contents	Contact Hours
1.	Stress in homogeneous and inhomogeneous media and analytical techniques	**5**
2.	Geometry and analysis of fractures, joints and faults	**8**
3.	Homogeneous strain and techniques of strain analysis including Fry method, grain centre method and Rf / Φ method	**8**
4.	Geometry of folds and their classification schemes	**3**
5.	Mechanism of folding and internal strain accommodation	**3**
6.	Shear zones and techniques of their analysis; Examples	**4**
7.	Analysis of foliation and lineation in rocks: Geometry, mechanics and significance	**3**
8.	Techniques of structural analysis in areas of superposed folding	**5**
9.	Different types of deformation mechanism	**3**
	Total	**42**

List of Practicals

1. Techniques of strain analysis: determination of finite strain of deformed objects using long- to short axis, center- to- center, Fry and Rf / Φ methods
2. Determination of finite strain from deformed fossils
3. Dip isogon method of fold analysis
4. Determination of strain in ductile shear zones and analysis of brittle fault zones
5. Structural analysis of folded terrains

11. Suggested Books:

S. No	Name of Books/Authors/Publishers	Year of Publication /Reprint
1.	Ramsay, J.G., Lisle, R.J. "*Techniques of Modern Structural Geology*", Volume 3: Applications of Continuum Mechanics in Structural Geology (Modern Structural Geology) -Academic Press	2001
2.	Davis, G. H. and Reynolds, S. J., "*Structural Geology of rocks and regions*", John Wiley & Sons, Inc.	1996
3.	Ghosh, S. K., "*Structural Geology: fundamentals and modern developments*", Pergamon	1993
4.	Twiss, R. J. and Moores, E. M., "*Structural Geology*", W.H. Freeman & Co.	1992
5.	Suupe, J., "*Principles of Structural Geology*", Prentice –Hall	1985

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-302** Course Title: **Mineral Exploration**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**
4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**
5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**
8. Pre-requisite**: ES-305: Economic Geology**
9. Objective: To introduce basic concepts of mineral exploration and role of a geologist starting from prospecting to mining.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Stages of exploration	**2**
2.	Geological indicators for mineral deposits, lithological and structural controls of mineralization	**4**
3.	Basic concepts of geological and geochemical exploration: orientation survey, lithogeochemical survey, weathering and soil formation, residual and transported soil and soil sampling, geochemical drainage survey, hydro-geochemical survey, biogeochemical exploration and geobotanical survey, atmo-geochemical survey	**10**
4.	Different techniques in mineral exploration: Drilling, sampling, bench mapping, underground mine mapping, preparation of geological plans and sections	**10**
5.	Delineation of subsurface ore bodies of different geometric shapes using various geological concepts and techniques	**6**
6.	Ore reserve estimation and grade calculation for different types of ore deposits	**4**
7.	Exploration during opencast and underground mining	**4**
8.	Application of standard computer software in mineral exploration	**2**
	Total	**42**

List of Practicals

1. Drawing of geological cross section
2. Delineation of ore body in 2- and 3-D based on surface & subsurface data
3. Calculation of ore quality and reserve estimation using various techniques

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Stevens, R., "*Mineral Exploration and Mining Essentials*" British Columbia Institute of Technology (BCIT)	2011
2.	Marjoribanks, R., "*Geological Methods in Mineral Exploration and mining*", Springer-Verlag, 2nd Ed.	2010
3.	Dhana Raju, R., "*Handbook of Mineral Exploration and Ore Petrology*", Geological Society of India	2009
4.	Rajendran, S., Srinivasamoorthy, K. and Aravindan S., "*Mineral Exploration : Recent Strategies*" New India Pub.	2007
5.	Moon, C.J., Whateley, M.K.G. and Evans, A.M., "*Introduction to Mineral Exploration*", Blackwell Science, 2nd Ed.	2006
6.	Talapatra, A.K., "*Modelling and Geochemical Exploration of Mineral Deposits*", Capital Publishing	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-303** Course Title: **Metamorphic Petrology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: ES-201: Basic Petrology**

9. Objective: To provide in-depth knowledge of phase rule, classification of metamorphic rocks and metamorphic assemblages

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Various types of metamorphism, metamorphic rocks and facies	**4**
2.	Texture, structure and classification of metamorphic rocks	**3**
3.	Phase rule, metamorphic reactions and phase equilibria in metamorphic rocks	**4**
4.	Graphical representation of various mineral assemblages in different P-T conditions	**4**
5.	Phase diagrams and petrogenetic grid for metamorphic assemblages in various grades of metamorphism	**4**
6.	Thermodynamics of metamorphic reactions and mineral assemblages in different metamorphic isograds	**6**
7.	Different types of metamorphic facies and their tectonic settings	**3**
8.	Mineral assemblages for different rock types in zeolite, prehnite, pumpellyite, greenschist, amphibolite, granulite, eclogite, and blueschist facies	**7**
9.	Mineral paragenesis and chemographic relations in metamorphism of calcareous, mafic and ultramafic rocks	**7**
	Total	**42**

List of Practicals

Megascopic and Microscopic studies of different metamorphic rocks

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Bucher, K. and Grapes, R., "*Petrogenesis of Metamorphic Rocks*", Springer	2011
2.	Winter, J.D., "*Principles of Igneous and Metamorphic Petrology*", Prentice Hall	2009
3.	Vernon, R.H and Clarke, G., "*Principles of Metamorphic Petrology*", Cambridge University Press	2008
4.	Kornprobst, J., "*Metamorphic Rocks and their Geodynamic Significance: A Petrological Handbook*", Springer	2002
5.	Spear, F.S., "*Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths*", Mineralogical Society of America Monograph	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-304** Course Title: **Ore Geology**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS : 15** **MTE: 30** **ETE: 4** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: ES-305: Economic Geology**

9. Objective: To know about various tools and techniques used for understanding the ore genesis processes which are responsible for formation of major ore deposits. Study of important and selected ore deposits of the world.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction and basic ideas about ore bodies, texture and structures of ores, ore forming processes	**4**
2.	Trace elements and their source characterization	**4**
3.	Stable isotopes (S, C, O and H) and their application in source characterization and estimation of physico-chemical conditions of ore formation	**6**
4.	Role of fluids in ore genesis; Fluid inclusion studies, geothermometry and geobarometry	**4**
5.	Classification of ore deposits; Ore deposits in important geological settings	**2**
6.	Magmatic ore deposits	**4**
7.	Hydrothermal ore deposits	**4**
8.	Volcanogenic sedimentary ore deposits	**4**
9.	Sedimentary, metamorphic and metamorphosed ore deposits	**4**
10.	Mineralization in space and time, crustal evolution	**2**
11.	Plate tectonics and metallogenesis	**4**
	Total	**42**

List of Practicals

1. Introduction to reflected light microscopy
2. Optical properties of ore minerals
3. Determination of reflectivity and hardness of ore minerals
4. Study of textures and structures in mineral specimen

5. Establishing the paragenesis of mineral associations

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Pohl, W.L., "*Economic Geology – Principles and Practices*", Wiley-Blackwell	2011
2.	Laznicka, P., "*Giant Metallic Deposits*", Springer	2006
3.	Robb, L., "*Introduction to Ore-Forming Processes*", Blackwell	2005
4.	Evans, A.M., "*An Introduction to Economic Geology and its Environmental Impact*", Blackwell Science	2001
5.	Misra, K.C., "*Understanding Mineral Deposits*", Springer	2000
6.	Evans, A.M., "*Ore Geology and Industrial Minerals: An Introduction*", Blackwell Science, 3rd Ed.	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-305** Course Title: **Economic Geology**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**
4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**
5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**
8. Pre-requisite**: ES-104: Crystallography and Mineralogy & ES-201: Basic Petrology**
9. Objective: To introduce fundamentals of economic geology, understanding of the processes related to the genesis of mineral deposits and applications of minerals in industries.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Historical development of economic geology and use of minerals in modern society	**2**
2.	The morphology and disposition of principal types of mineral deposits	**3**
3.	Major theories of mineral deposit genesis	**3**
4.	Formation of mineral deposits due to endogenic processes: magmatic, metasomatic , hydrothermal, volcanic exhalation and metamorphism	**10**
5.	Formation of mineral deposits due to exogenic processes: sedimentary, weathering, placer, oxidation and supergene enrichment	**8**
6.	Classification of mineral deposits	**2**
7.	Geology of important economic deposits of India: Bauxite, iron, manganese, copper, lead, zinc, gold, chromite, diamond, coal and petroleum	**9**
8.	Mineralogy and genetic aspects of industrial minerals: asbestos, barite, clay, graphite, magnesite, mica, phosphorites	**5**
	Total	**42**

List of Practicals:

1. Locating different important mineral deposits on outline map of India /world.
2. Megascopic study of ore specimens/ industrial minerals
3. Microscopic study of important ore minerals
4. Preparation of polished ore specimen

11. Suggested Books:

S. No	Name of Books/ Authors/Publishers	Year of Publication/reprint
1.	Walter,L.P., "*Economic Geology: Principles and Practice*", Wiley-Blackwell Publishers	2011
2.	Robb, L., "*Introduction to Ore Forming Processes*", Blackwell Publishers	2005
3.	Mookherjee, A., "*Ore Genesis: A Holistic Approach*", Allied Publishers	1999
4.	Evans, A.M., "*Ore Geology and Industrial Minerals: An Introduction*", Blackwell Science, 3rd Ed.	1992
5.	Bannerjee, D.K., "*Mineral Resources of India*", The World Press	1986
6.	Bateman, A. M. and Jensen, M.L., "*Economic Mineral Deposits*", John Wiley & Sons, 3rd Ed.	1981

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-306** Course Title: **Geomorphology**
2. Contact Hours: **L: 2** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory: 2** **Practical: 0**
4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**
5. Credits**: 3** 6. Semester**: Spring** 7. Subject Area**: DCC**
8. Pre-requisite**: Nil**
9. Objective: To impart basic understanding of different types of landforms and their evolution processes and their significance in understanding the earth's interior and climate.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Geomorphology as a branch of geology and its relation to other branches	**1**
2	Weathering, erosion and deposition, effects of climatic factors on different types of rocks	**4**
3	Erosion by running water, stages of river development, concept of base level of erosion, ox-bow lakes, karst topography, fluvial landforms	**4**
4	Wind erosion, desertification, formation of dunes and other depositional processes by wind, aeolian landforms	**4**
5	Ice, glaciers and ice sheets, moraines, classification of glaciers, glacial landforms	**4**
6	Coastal processes, marine landforms	**4**
7	Quantitative geomorphology	**2**
8	Terrain evaluation and its applications	**2**
9	Geomorphology and seismic risk	**2**
10	Geomorphology and interactions with Society	**1**
	Total	**28**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Harvey, A., "*Introducing Geomorphology- A guide to landform and processes*". Dunedin Academic Press, Scotland	2012
2.	Huggett, R., "*Fundamentals of Geomorphology*", Routledge	2007
3.	Ritter, D.F., Kochel, R.C., Miller, J.R., "*Process Geomorphology*", Waveland	2006
4.	Bloom, A., "*Cenozoic Geomorphology*", Eastern Economy	1998
5.	Thornbury, W.D., "*Principles of Geomorphology*", Balkema	1995
6.	Holmes, A., "*Physical Geology*", Ronald Press	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN- 321** Course Title: **Gravity and Magnetic Prospecting**
2. Contact Hours : **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs) : **Theory:3** **Practical:0**
4. Relative Weight age: **CWS15** **PRS15** **MTE30** **ETE40** **PRE:0**
5. Credits:**4** 6. Semester: **Autumn** 7. Subject Area: **DCC**
8. Pre-requisite: **Nil**
9. Objective: To emphasize the importance of gravity and magnetics in geophysical exploration.

10. Details of Course:

S. No.	Content	Contact Hours
1.	Introduction to gravity & magnetics as inverse square fields, physical properties of earth materials and their variability	**2**
2.	Data acquisition procedures for different types of gravity & magnetic surveys (Land, marine and air-borne), gravity gradiometry, borehole gravimetry	**6**
3.	Data cleaning (Corrections) of gravity and magnetic data of different platforms (land, marine and airborne), regional-residual separation procedures	**8**
4.	Forward modelling problem solutions for both gravity and magnetic source models of regular geometry, forward modelling algorithms for gravity and magnetic anomaly sources of arbitrary shape (2½ D and 3D).	**9**
5.	Qualitative Depth rules and semi-quantitative methods of interpretation.	**3**
6.	Analytic signal method for interpretation of gravity and magnetic data. Werner deconvolution method, quantitative interpretation for 2D-, 2½D- and 3D- gravity and magnetic anomaly sources, spectral analyses, gravity and magnetic inversion concepts	**9**
7.	Equivalent stratum principle in gravity & magnetics and its applications, geological applications of gravity and magnetics.	**5**
	Total	**42**

List of practicals

1. Density and magnetic susceptibility measurements on different rocks
2. Land gravity data acquisition with a gravimeter and data cleaning
3. Land magnetic data acquisition
4. Different regional-residual separation methods – graphical, ring residual, analytic continuation and derivative methods through exercises.
5. Qualitative interpretation of gravity anomaly maps and profiles
6. Quantitative interpretation exercises for both gravity and magnetic data of different surveys (land, marine and air-borne)
7. Methods for transforming geophysical interpretation models to geological interpretation

11. Suggested Books:

S. No.	Name of Books/ Authors/ Publishers	Year of Publication/ reprint
1.	Campbell, W.H "*Introduction to geomagnetic fields*"	2003
2.	Watts, A.B "*Isostasy and flexure of the lithosphere*", Cambridge University Press, NY	2001
3.	Parasnis, D.S "Principles of applied geophysics", Chapman & Hall, London	1997
4.	Telford,W.M., Geldart,L.P., Sheriff, R.E., Keys, D.A "*Applied geophysics"*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.	1988
5.	Hinze, W.J "*The utility of regional gravity and magnetic anomaly maps"*, SEG Publication, Oklahoma	1985
6.	Grant, F.S., West, G.F "*Interpretation theory in applied geophysics"*, McGraw-Hill Book Co., NY.	1965

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-322** Course Title**: Electromagnetic Prospecting**
2. Contact Hours : **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs) : **Theory:3** **Practical:0**
4. Relative Weightage **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**
5. Credits : 4 6. Semester: **Spring** 7. Subject Area: **DCC**
8. Pre-requisite: **Nil**
9. Objective: To impart knowledge of theory, data acquisition, processing, interpretation and application of electromagnetic prospecting methods for geophysical exploration
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Methods of Electromagnetic Prospecting: physical principles, dip angle technique, intensity measurements, phase component measurements, airborne electromagnetic method	**4**
2.	Depth sounding methods: parametric and geometric sounding, data acquisition for different source-receiver geometries and their interpretation	**6**
3.	Maxwell's equations in time and frequency domain, wave equation, Helmholtz equation, long wavelength approximation, boundary conditions, polarization of electromagnetic field	**6**
4.	Solution of the wave equations; Schelkunoff potential, wholespace Green's function, time-domain Green's function and their applications for different source geometries	**4**
5.	Harmonic line source, loop source, conducting sheet in a dipole field, conducting half-space in dipole field, multiple conductor, transient response, layered earth response	**4**
6.	Reflection and refraction of plane waves, wave impedance, plane wave impedance of an n-layered isotropic earth, normal incidence, oblique incidence	**6**
7.	MT/AMT formulation of response of 1-D earth; MT sounding and profiling, telluric measurements, telluric data analysis, depth rules; IP methods	**6**
8.	Applications and recent case studies	**6**
	Total	**42**

List of Practicals

1. Estimation of model parameters from the Turam data
2. Interpretation of electromagnetic response using phasor diagram
3. Field procedure and recording of VLF data
4. Analysis of VLF data by filtering
5. Field procedure and data acquisition using time domain electromagnetic instrument
6. Analysis and interpretation of decay curves of time domain electromagnetic response
7. Magnetotelluric field setup, system and sensors
8. Processing and analysis of time series data recorded in field

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication/ reprint
1.	Zhdanov, M.S., *"Geophysical Electromagnetic Theory and Methods"*, Elsevier	2009
2.	Parasnis, D.S., "*Principles of Applied Geophysics*", Chapman & Hall	1997
3.	Nabighian, M.N., "*Electromagnetic Methods in Geophysics Vol. II Applications*", Society of Exploration Geophysics	1991
4.	Telford, W.M. Geldart, L.P, and Sheriff, R.E., "*Applied Geophysics*", Cambridge University Press	1990
5.	Nabighian, M.N., "*Electromagnetic Methods in Geophysics*", Vol. I Theory, Society of Exploration Geophysics	1987
6.	Wait, J.R., "*Geoelectromagnetism*", Academic Press	1982

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-323** Course Title**: Electrical Prospecting**
2. Contact Hours : **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory:3** **Practical:0**
4. Relative Weightage: **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**
5. Credits :4 6. Semester: **Autumn** 7. Subject Area: **DCC**
8. Pre-requisite: **NIL**
9. Objective: To impart knowledge of the theory and applications of electrical prospecting methods of geophysical exploration

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Electrical properties of rocks, mode of conduction, fundamental assumptions used in electrical prospecting	**5**
2.	Basic laws and equations, effect of anisotropy and inhomogeneity	**5**
3.	Point and line sources; Relationship between point and line source potential distribution, half-space solution, apparent resistivity, depth of investigation and vertical resolution	**5**
4.	Measuring systems, electrode configurations, principle of superposition and principle of reciprocity, sounding and profiling techniques	**4**
5.	Potential distribution over a layered earth, the Kernel function, resistivity transform function, recurrence relations, apparent resistivity functions	**5**
6.	Computation of apparent resistivity model curves using digital filter theory, applications to field data, transformation of data, inclined layer problem	**5**
7.	Data interpretation: Approximate methods, automatic iterative methods, principle of equivalence and suppression in data interpretation	**3**
8.	Electrical profiling of near-vertical contact, dike, sphere and cylinder, Resistivity imaging, field setup and data recording and inversion.	**6**
9.	Self-potential method; Induced polarisation method; Charged body method of electrical prospecting	**4**
	Total	**42**

List of Practicals

1. Measurement of resistivity for rock, soil and fluid samples using four electrode methods
2. Recording of vertical electrical sounding data using Schlumberger, Wenner and two-electrode configurations and generation of anomaly curves
3. Recording of electrical resistivity profiling data, their analysis and interpretation
4. Graphical interpretation of resistivity sounding data using partial curve matching technique
5. Field set-up and data acquisition procedure for multi-electrode resistivity survey
6. Data acquisition and generation of pseudo section for resistivity imaging
7. Depth of investigation and vertical resolution of field resistivity data
8. Inversion of 2D resistivity imaging data

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	Kearey, P., Brooks, M, and Hill, I., "*An Introduction to Geophysical Exploration*", Blackwell	2002
2.	Parasnis, D.S., "*Principles of Applied Geophysics*", Chapman & Hall	1997
3.	Zhdanov M. S. and Keller G. V. , "*The Geoelectrical methods in Geophysical exploration*", Elsevier	1994
4.	Keller, G.V, and Frischknecht, F.C., "*Electrical Methods in Geophysical Prospecting*", Pergamon	1981
5.	Patra, H.P., "*Geosounding Principles: Time Varying Geoelectric Soundings*", Elsevier	1980
6.	Koefoed, O., "*Geosounding Principles: Resistivity Sounding Measurements*", Elsevier	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-324** Course Title: **Seismic Prospecting**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical:0**

4. Relative Weightage**: CWS:15** **PRS:15** **MTE:30** **ETE:40** **PRE:0**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**:** **Nil**

9. Objective: To introduce methods of seismic data acquisition and processing used in oil industry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Role of seismic method in hydrocarbon exploration, basic steps of seismic prospecting	**2**
2.	**Basic Principles:** Reflection and refraction of seismic waves in horizontally layered Earth and for dipping layer boundaries, analysis of travel time curves	**4**
2.	**Acquisition:** Two- and three-dimensional survey design, purpose of such design, land and marine data acquisition, source and receiver characteristics, geophone grouping.	**7**
3.	**Processing:** Processing and preprocessing steps, geometry, editing, muting, static correction, geometrical spreading and attenuation correction.	**7**
4.	**Deconvolution:** Deconvolution as a tool for removing noise and improving resolution; spiking, deterministic and probabilistic deconvolution; removal of multiples.	**7**
5.	**Stacking:** Purpose of stacking, normal moveout and dip moveout corrections, stacking process, problems encountered during stacking and their solution, improvement in signal to noise ratio.	**7**
6.	**Velocity Analysis:** Factors affecting seismic wave velocity, Dix method, constant velocity stack method, variable velocity stack, semblance analysis, velocity spectra method.	**6**
7.	**Migration:** Basic concepts of migration, why it is required.	**2**
	Total	**42**

List of Practicals

1. Determination of layer thickness and velocity from travel time curves.
2. Estimation of static correction.
3. Generation of synthetic seismogram.
4. Estimation of reflectivity series using deconvolution.
5. Estimation of geometrical parameters for a field layout.
6. Determination of fold of stacking at various midpoints for a given field layout.
7. Estimation of stacking velocity for various values of maximum offset and comparison with RMS and average velocity.
8. Normal moveout and dip moveout calculation.

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Gadallah, M.R. and Fisher, R., "*Exploration Geophysics*", Springer.	2009
2.	Costain J.K.and Çoruh, C, "*Basic Theory of Exploration Seismology*", Elsevier.	2004
3.	Yilmaz, O., "*Seismic Data Analysis Processing, Inversion and Interpretation of Seismic Data*", Society of Exploration Geophysicists	2001
4.	Sheriff, R.E. and Geldart, L.P., "*Exploration Seismology*", Cambridge Univ. Press.	1995
5.	Telford, W.M., Geldart, L.P. and Sheriff, R.E., "*Applied Geophysics*", Cambridge Univ. Press.	1990
6.	Dobrin, M.B. and Savit, C.H., "*Introduction to Geophysical Prospecting*", McGraw Hill.	1988
7.	Robinson, E.A., Durrani, T.S. and Peardon, L.G., "*Geophysical Signal Processing*", Prentice-Hall International	1986
8.	Hatton, L., Worthington, M.H. and Makin, J., "*Seismic Data Processing Theory and Practice*", Blackwell Scientific Publications	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-325** Course Title: **Seismology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:15** **PRS:15** **MTE:30** **ETE:40** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**:** **Nil**

9. Objective: To introduce fundamentals of earthquakes, their generation mechanism and effect of Earth structure on seismic wave propagation and characteristics of instruments required to record them.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Earthquakes, causes of their occurrence, Earth structure, information about earthquake source and earth structure to be determined from records of earthquakes, usefulness of study of Seismology	**6**
2.	**Elasticity and Seismic Waves:** Stress, strain, equation of motion, wave equation and its solution, P and S waves.	**6**
3.	**Body Wave and Ray Theory:** The eikonal equation and ray geometry, travel time curves in layered Earth, continuous media and spherical Earth model, travel time curves, wave amplitude, energy and geometrical spreading, partitioning of seismic energy at a boundary, attenuation and scattering of seismic waves.	**10**
4.	**Surface Waves and Free Oscillations:** Free surface interactions, Rayleigh waves, Love waves, Dispersion, measurement of group and phase velocity, Tsunamis, Free oscillations.	**6**
5.	**Seismometry:** Inertial pendulum system, Earth noise, Electromagnetic and force feedback instruments.	**6**
6.	**Seismic Sources:** Magnitude scales, Faulting sources, equivalent body forces, elastostatics, elastodynamics, seismic moment tensor.	**8**
	Total	**42**

List of Practicals:

1. Seismic observatory practices
2. Seismogram reading
3. Earthquake location
4. Travel time curves
5. Estimation of seismic wave velocity and Poisson's ratio
6. Construction of a seismometer
7. Estimation of earthquake magnitude
8. Fault plane solution

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Havskov, J. and·Ottemöller, L., "*Routine Data Processing in Earthquake Seismology*", Springer.	2010
2.	Shearer, P.M., "*Introduction to Seismology*", Cambridge Univ. Press.	2009
3.	Stein, S. and Wysession, M., "*An Introduction to Seismology, Earthquakes and Earth Structure*", Blackwell Publishing.	2003
4.	Pujol, J., "*Elastic Wave Propagation and Generation in Seismology*", Cambridge Univ. Press.	2003
5.	Aki, K. and Richards, P.G., "*Quantitative Seismology*", University Science Books.	2002
6.	Udias, A, "*Principles of Seismology*", Cambridge Univ. Press.	1999
7.	Lay, T. and Wallace, T.C., "*Modern Global Seismology*", Academic Press	1995
8.	Bullen, K.E. and Bolt, B.A., "*An Introduction to the Theory of Seismology*", Cambridge Univ. Press.	1985

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-341** Course Title: **Himalayan Geology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC-I**

8. Pre-requisite**: Nil**

9. Objective: To provide basic knowledge of geology, structure and tectonics of the Himalaya.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction, importance and significance of the Himalaya, their morphology, classification of Himalayas, regional, physical and geological.	**4**
2.	Formation of the Himalayas, Indian plate margin, plate movement and rise of the Himalaya, Himalayan foredeep, Indo-Gangetic plain and its relation with peninsular India.	**8**
3.	Main tectonic boundaries.	**4**
4.	Geology of Lesser Himalaya, geological history and structures, sedimentary basins and igneous and metamorphic belts.	**4**
5.	Geology of Higher Himalaya, structural framework, inverted metamorphism, Magmatism and its geological history.	**6**
6.	Tethys Himalaya, its geology and structure, and relationship with higher Himalayas and trans-Himalayan geology	**4**
7.	Concept of exhumation in the Himalaya	**4**
8.	Himalayan seismicity, its characteristics, major earthquakes, gravity and magnetotelluric characteristics and structure of the Himalaya	**4**
9.	Mineral deposits and metallogeny of the Himalaya	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Srikantia S.B. and Bhargava, O.N. , "*Geology of Himachal Pradesh*", Geological Society of India	2005
2.	Kumar, G. "*Geology of Uttar Pradesh and Uttaranchal*", Geological Society of India	2005
3.	Valdiya, K. S. "*Geology of Kumaon Himalayas*", Wadia Institute of Himalayan Geology	2004
4.	Brown G.G., Hawkesworth C.J. and Wilson, R.C.L., "*Understanding the Earth- A New Synthesis*", Cambridge Univ. Press	1992
5.	Gansser A., "*Geology of Himalayas*", Wiley and Sons	1964

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-342** Course Title: **Advanced Stratigraphy and Facies Modelling**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory :3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DEC-II**

8. Pre-requisite**: ES-202: Sedimentology**

9. Objective: To impart knowledge of advanced stratigraphic methods including sequence stratigraphy and their applications in interpreting depositional environments and reconstructing characteristic 3-D facies models for basin evolution.

10. Details of Course:

S. No.	Contents	Contact hours
1.	Introduction to stratigraphic principles and correlation	**3**
2.	Magnetostratigraphy, Seismic stratigraphy, Isotope stratigraphy, Event stratigraphy and Cyclostratigraphy: concept and applications	**6**
3.	Eustasy and sea level changes – concept and controls	**2**
4.	Classification and characteristics of common marine and non-marine sedimentary environments	**6**
5.	Concept of Facies, facies association,	**3**
6.	2-D and 3-D facies modeling of depositional environments	**5**
7.	Sequence stratigraphy – basic concepts and principles	**4**
8.	Sequence stratigraphy of common continental and marine sedimentary environments	**8**
9.	Basin evolution – concept and implications, interpretation of geophysical logs, applications in petroliferous basins	**5**
	TOTAL	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Nichols, G.: *Sedimentology and stratigraphy*, 2nd Ed. Wiley-Blackwell	2009

2.	Boggs, Sam (Jr.): Principles of *Sedimentology and Stratigraphy, 4th Ed*. Pearson/Prentice Hall.	2006
3.	Catuneanu, O.: *Principles of Sequence Stratigraphy*. Elsevier.	2006
4.	Allen, P.A. and Allen, J.R.: *Basin Analysis: Principles and applications*. Blackwell publishing	2005
5.	Van Loon A.J.: *Cyclic development of sedimentary basins*. Elsevier.	2005
6.	Brookefield, M.E.: *Principles of Stratigraphy*. Blackwell Publishing.	2004
7.	Doyle, P., Bennett, M.R. and Baxter, A.N.: *The key to Earth history*. John Wiley and Sons.	1996
8.	Reading, H.G.: *Sedimentary Environments and Facies*. 6th Ed., Blackwell Scientific Publ., Oxford.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-343** Course Title: **Carbonate Sedimentology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical : 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC-I**

8. Pre-requisite**: ES-202: Sedimentology**

9. Objective: To provide knowledge on the origin, composition, identification of constituents, cement in carbonate rocks and depositional environments.

10. Details of Course:

S. No.	Contents	Contact hours
1.	Constituents of carbonate sediments and limestone	**3**
2.	Carbonate mineralogy and chemistry	**4**
3.	Typical sedimentary textures and structures inherent to carbonates, and their significance for interpreting environmental setting	**3**
4.	Diagenesis of carbonate rocks	**4**
5.	Dolomites and dolomitization models	**4**
6.	Shallow marine and deep marine carbonate depositional systems	**5**
7.	Lacustrine and re-deposited carbonates	**4**
8.	Carbonate facies through time	**4**
9.	Application of sequence stratigraphy in carbonate depositional systems	**4**
10.	Carbonate porosity – classification, diagenetic modifications, mode of evolution, carbonate reservoirs and their modeling	**7**
	TOTAL	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Boggs, S., (Jr.): *Petrology of sedimentary rocks, 2nd Ed*. Cambridge.	2009
2.	Nichols, G.: *Sedimentology and stratigraphy*, 2nd Ed. Wiley-Blacwell	2009
3.	Tucker, M.E., Wright V.P.: *Carbonate sedimentology*. Blackwell Science	2002
4.	Moore, C.H.: *Carbonate reservoirs*. Elsevier.	2001
5.	Reading, H.G.: *Sedimentary Environments and Facies*. 6th Ed., Blackwell Scientific Publ., Oxford.	1996
6.	Scholle, P.A., Bebout, D.G., and Moore, C.H.: *Carbonate Depositional Environments (4th edition)*. American Association of Petroleum Geologists, Memoir 33, 708p	1983
7.	Tucker, M.E.: *Sedimentary petrology- an introduction*, Blackwell Scientific Publ., Oxford	1981

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-344** Course Title: **Basin Analysis**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory:3** **Practical:0**
4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**
5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DEC-I / II**
8. Pre-requisite**: Nil**
9. Objective: To understand the basin formation process and to study the depositional sedimentary environment
10. Details of Course:

S. No.	Contents	Contact hours
1.	Introduction to Sedimentary Basin	**2**
2.	Basin mapping methods: Litho facies assemblage maps, Geophysical techniques, Lithofacies mapping with petrophysical logs	**6**
3.	Environment and paleoslope interpretation, Paleocurrent analysis, Paleogeographic synthesis	**4**
4.	Interpretation of Fluvial, Lacustrine and Eolian Sequences	**6**
5.	Marginal marine and shallow marine sequences, deltas and deltaic environments, coast-shelf interface	**4**
6.	Sequence in deep marine siliciclastic deposits, Carbonate depositional environments, Mixed carbonate clastic system	**5**
7.	Basin subsidence and thermal history	**2**
8.	Basin analysis in suture zone	**1**
9.	Sedimentary basin associated with different plate margins	**6**
10.	Sedimentary basins of India from Precambrian to Recent	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Leeder, M., *Sedimentology and Sedimentary basins, from Turbulence to Tectonics*, Wiley-Blackwell	2011
2.	Miall, A. D., *Principles of sedimentary Basin Analysis*, Springer	2010
3.	*Sedimentary Basins of India: Recent Developments*: Gondwana Geological Society,	2010
4.	Allen, P.A. and Allen, J. A., *Basin Analysis Principle and Applications*, Blackwell	2005
5.	*Reineck, H.E. and Singh, I.B., Depositional Sedimentary Environments: With Reference to Terrigenous Clastics*, Springer	1975

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-345** Course Title: **Rock and Soil Mechanics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage: **CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester: **Autumn** 7. Subject Area: **DEC-I**

8. Pre-requisite**: Nil**

9. Objective: To understand strength parameters and response of rocks and soil to Engineering structures

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Definitions and importance of Rock and Soil Mechanics	**2**
2.	Classification of rocks – intact rock and rock mass; Engineering properties of intact rocks	**5**
3.	Strength criteria of rocks and soils – laboratory and in-situ determination	**5**
4.	Engineering aspects of weathering and impacts on planning of Engineering projects	**2**
5.	Rock mass classifications RMR and Q systems, applications in assessing support requirements and strength properties of rock mass	**6**
6.	Weight –volume relationship of soil, Index properties of soil	**5**
7.	Permeability of soil; consolidation of soil	**5**
8.	Shear strength parameters of soil and their determination in laboratory	**4**
9.	Soil exploration techniques	**4**
10.	Bearing capacity of soils and foundations of Engineering Structures	**4**
	Total	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Coduto,D.P., William, A.K., Young, M.C.R. "*Geotechnical Engineering: Principles & Practices*", Prentice Hall	2010
2.	Potts, D.M., Jardine, R.J. and Higgins, K.G. "*Advances in Geotechnical Engineering*", Thomas Telford Services Ltd.	2004
3.	Jaeger, J.C. & Cook, N.G.W., "*Fundamentals of Rock Mechanics*" ,Cambridge University Press	1969
4.	Ranjan,G.& Rao, A.S.R., "*Basic & Applied Soil Mechanics*", New Age International (P) Ltd, Publishers	2000
5.	Zimmerman,R.,Cook,J.C.,Jaeger, N.G and Cook, N.G.W. "*Fundamentals of Rock Mechanics*", John Wiley Sons Inc.	2009
6.	Singh, B.& Goel, R.K ., "*Rock mass classification: A practical approach in Civil Engineering*", Elsevier	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-346** Course Title: **Applied Geochemistry**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE: 25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC II**

8. Pre-requisite**: Nil**

9. Objective: To introduce geochemistry as a tool in understanding the Earth

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Origin of Earth, Differentiation and formation of core, mantle, crust, hydrosphere, atmosphere, Earth composition	**4**
2.	**Reaction K inetics:** Chemical thermodynamics, chemical equilibrium, free-energy, oxidation-reduction, ion-exchange, reaction rates and mass transfer, geochemical classification of elements, phase equilibria	**8**
3.	**Crystal C hemistry:**, Various bonds in minerals, silicate structure, isomorphism, polymorphism, substitution, problem exercises	**6**
4.	**Aqueous So lutions:** Solute hydrolysis, electrolyte solutions, activity concepts, carbonate equilibria, silicate equilibria, chemical sedimentology, solution-mineral interface, problem exercises	**8**
5.	**Isotope G eochemistry:** Radiogenic isotopes, age dating, petrogenesis, stable isotopes in environment, problem exercises	**8**
6.	**Organic G eochemistry:** Organic matter characterization, hydrocarbons and fossil fuels, biogeochemical cycles of carbon, phosphorus, nitrogen, silicon, and sulfur	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Schlesinger, W.H. and Bernhardt, E.S. "*Biogeochemistry: An Analysis of Global Change*", Associated Press, 3rd Ed.	2013
2.	Killops, S.D. and Killops, V.J., "*Introduction to Organic Geochemistry*", Wiley Publ.	2010
3.	Walther, J.V., "*Essentials of Geochemistry*", Jones and Bartlette Publ.	2008
4.	McSween, H., Richardson, S.M., and Uhle, M.E., "*Geochemistry: Pathways and Processes*" Overseas Press	2006
5.	Krauskopf, K., and Bird, D.K.,"*Introduction to Geochemistry*", McGraw-Hill Publ.	2005
6.	Holland, H.H. (Ed.), "*A Treatise on Geochemistry*" Prentice-Hall Publ.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT/ CENTRE*:* **Department of Earth Sciences**

1. Subject Code: **ESN-372** **C**ourse Title: **Geomagnetism**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory3** **Practical** 0

4. Relative Weightage: **CWS:25** **PRS:0** **MTE: 25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester: **Spring** 7. Subject Area: **DEC – I / II**

8. Pre-requisite: **Nil**

9. Objective: To introduce morphology and the source mechanism of spatial and temporal variations of earth's natural magnetic field and their implication in exploration geophysics.

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Introduction: Geomagnetic elements and their distribution on a global scale. Classification – polar zone, auroral zone, auroral oval, mid latitude and equatorial regions. Geomagnetic variations and geomagnetic time scale. Current model for interaction of solar wind with the geomagnetic field envelope. Ionosphere and its importance.	**5**
2.	Magnetospheric contributions to terrestrial magnetic field, marine magnetic anomalies and geomagnetic polarity time scale. Spherical, cap spherical and ellipsoidal harmonic analysis, harmonic analysis as inverse problem, Schmidt normalization, interpolation of harmonic coefficients in terms of multipoles. Decomposition of geomagnetic field into internal and external parts.	**10**
3.	Solar and lunar daily variation, morphology. Quiet days and disturbed days, geomagnetic indices, source mechanisms, equivalent current systems – toroidal and poloidal, equivalent current stream function linkage with harmonic coefficients.	**5**
4.	Geomagnetic disturbances, sudden storm commencement, magnetic storms and substorms (bays), sources of storms and substorms, typical magnetic storms from Indian geomagnetic observatories, polar magnetic storms, Polar electrojet and Equatorial electrojet.	**5**
5.	Pulsations, atmospherics, whistlers, VLF and EM wave emissions, Spherics, Solar cycle variations, international scientific organization devoted geomagnetic studies, geomagnetic equipment, network of Indian geomagnetic	**6**

	observatories.	
6.	Inverse problems of geomagnetism, inversion of daily and secular variation data in terms of conductivity structure of crust, mantle and core. GDS studies, linkage with magnetic storm activity.	**5**
7.	Elements of magnetohydrodynamics and earth's internal dynamics, Elsasser's geomagnetic dynamo model, magnetic field environments of other members of solar system and knowledge gained by their studies.	**6**
	Total	**42**

11. **Suggested Books:**

S. No	**Name of Books/ Authors**	**Year of Publication**
1.	Parkinson, W.D., "*Introduction to Geomagnetism*", Scottish Academic Press.	1983
2	Jacobs, J.A., "*Geomagnetism*", Academic Press.	1988
3.	Chapman, S. and Bartels, J., "*Geomagnetism*", Oxford University Press.	1962
4.	Backus, G., Parker, R., Constable, C., "*Foundations of Geomagnetism*", Cambridge University Press.	1996
5.	Kono, M., "*Geomagnetism*", Elsevier.	2009
6.	Campbell, W.H., "*Introduction to geomagnetic fields*", Second Edition, Cambridge University Press.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-374** Course Title**: Marine Geophysics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory**:3 **Practical:0**

4. Relative Weightage**: CWS: 25** **PRS:0** **MTE: 25** **ETE:50** **PRE:0**

5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **DEC – I / II**

8. Pre-requisite: **Nil**

9. Objective: To introduce geophysical methods for marine exploration with emphasis on techniques of data acquisition and position location.

10. Details of Course**:**

S. No.	Contents	Contact Hours
1.	Introduction to marine geophysics, basic concepts	**2**
2.	Marine resources including hydrocarbons, manganese nodules, other minerals	**5**
3.	Radio and satellite positioning, basic concepts, methods of data collection and processing	**4**
4.	Marine gravity and magnetics, data acquisition, processing, interpretation methods specific to marine environment	**5**
5.	Acquisition of seismic data at sea, special data acquisition techniques, marine specific processing methodology,	**7**
6.	Marine seismic signal processing and interpretations, specific issues related to marine environment, their similarities and differences with land seismic data processing techniques	**7**
7.	Marine MT, data acquisition, instruments, methodology of data processing specific to marine environment	**7**
8.	Geological Applications, sea floor spreading, mineral and petroleum exploration	**5**
	Total	**42**

11. Suggested Books

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Emery, W. and Thomsen, R., "*Data Analysis methods in Physical Oceanography*", Elsevier	2004
2.	Hwang, C., Schum, C. and Li, J., "*Satellite altimetry for geodesy, geophysics and oceanography*", Springer-Verlag	2004
3.	Parkes,G.E and Hattoi, L., "*The Marine Seismic Source*", Springer	2001
4.	Jones, E J W., " *Marine Geophysics*", John Wiley and Sons	1999
5.	Verma, R.K.., "*Offshore Seismic Exploration*", Gulf Pub Co	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-401** Course Title: **Principles of Remote Sensing**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory: 2** **Practical: 0**

4. Relative Weight age: **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 25** **PRE: 0**

5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **DCC**

8. Pre-requisite: **Nil**

9. Objective of Course: To introduce the principles of satellite based remote sensing for studying earth resources

10. Details of Course:

Sl.No.	Contents	Contact Hours
1.	Introduction, development of remote sensing technology, advantages	**3**
2.	Different platforms of remote sensing; EM spectrum, solar reflection and thermal emission remote sensing	**3**
3.	Interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission	**3**
4.	Interaction mechanisms of EM radiation with ground, spectral response curves	**4**
5.	Principles of image interpretation, digital image processing	**4**
6.	Multi-spectral scanners and imaging devices; Salient characteristics of LANDSAT, IRS, Cartosat, ResourceSat, SPOT, IKONOS, QuickBird, GeoEye sensors and their applications	**3**
7.	Image characteristics and interpretation of different geological landforms, structures and major igneous, sedimentary and metamorphic rock types	**5**
9.	Remote sensing as a fore-runner in all exploration programs, Remote Sensing integration with GIS, Limitations of Remote Sensing	**3**
	Total	**28**

11. Suggested Books:

S. No	Name of Books/ Authors/Publishers	Year of Publication/reprint
1.	Campbell, J. B. and Wynne, R. H., *"Introduction to Remote Sensing"*, 5th Ed., The Guildford Press, New York	2011
2.	Jensen, J. R., *Remote Sensing of the Environment: An Earth Resource Perspective* (*2nd Ed.*), Prentice Hall.	2009
3.	Lillesand, T.M., Kiefer, R.W. and Chapman, J.W., "*Remote Sensing and Image Interpretation*", 5th Ed., John Wiley & Sons	2007
4.	Gupta, R. P., "*Remote Sensing Geology*", 2nd Ed., Springer	2003
5.	Drury, S. A., "*Image Interpretation in Geology*", 2nd Ed., Allen & Unwin	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN-402** Course Title: **Geophysical Prospecting**

2. Contact Hours : **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits : **4** 6. 6. Semester: **Spring** 7. Subject Area**: DCC**

8. Pre requisite: **Nil**

9. Objective: To introduce basic concepts of geophysical methods and their applications in solving geological problems

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Overview and importance of various geophysical methods in geological studies	**2**
2	**Gravity M ethod:** Basic principles, gravity anomalies, gravimeters, data acquisition procedures, data reduction and processing, interpretation of Bouguer anomalies for basic geometrical shapes, depth rules; Applications	**8**
3	**Magnetic M ethod:** Basic principles, magnetic anomalies, magnetometers, data acquisition procedures, data reduction and processing, interpretation of magnetic anomalies for basic geometrical shapes, depth rules; Applications	**8**
4	**Seismic M ethods:** Refraction, reflection and attenuation of seismic waves, geophones and hydrophones, recording instruments, seismic refraction method, travel time curves for flat and dipping interfaces, interpretation of refraction profiles, seismic reflection method, CDP shooting, geophone grouping, elementary ideas about processing and interpretation of seismic reflection data; Applications	**10**
5	**Electrical M ethod:** Apparent resistivity, sounding and profiling, different electrode configurations, field procedures, resistivity meters, data interpretation using curve matching method, electrical section; Applications	**7**
6	**Electromagnetic Me thods:** Basic concepts, dip angle techniques, measurement of amplitude and phase, various transmitter and receiver loop configurations, response curves, airborne electromagnetic method; Applications	**7**
	Total	**42**

List of Practicals

1. Determination of velocity and thickness of bed from seismic refraction and reflection survey
2. Determination of dip of bed from seismic refraction survey
3. Preparation of regional and local gravity anomaly map
4. Calculation of depth and extent of simple structure from gravity survey
5. Collection, processing and interpretation of magnetic data
6. Collection, processing and interpretation of resistivity data for Schlumberger and Wenner configurations

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication/ reprints
1.	Lowrie, W., "*Fundamentals of Geophysics*", Cambridge University Press.	2007
2.	Kearey, P., Brooks, M. and Hill, I., "*An Introduction to Geophysical Exploration*", Blackwell.	2002
3.	Telford, W.M., Geldart, L.P. and Sheriff, R.E., "*Applied Geophysics*", Cambridge University Press.	1999
4.	Parasnis, D.S., "*Principles of Applied Geophysics*", Chapman and Hall.	1997
5.	Dobrin, M.B. and Savit, C.H., "*Introduction to Geophysical Prospecting*", McGraw-Hill.	1988
6.	Robinson, E.S., Coruh, C., "*Basic Exploration Geophysics*", John Wiley & Sons.	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN- 403** Course Title: **Principles of Geographic Information Systems**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory: 2** **Practical: 0**

4. Relative Weightage: **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **DCC**

8. Pre-requisite: **Nil**

9. Objective: To provide basic understanding about GIS Technology

10. Details of Course:

S. No	Contents	Contact Hours
1.	GIS definition, purpose of GIS, Differences between GIS and CAD, DBMS	**2**
2.	Different Components of GIS, Hardware and software requirements of GIS	**3**
3.	Concepts of thematic layers, topology, Co-ordinate systems	**3**
4.	Raster and vector data models, their associated advantages and disadvantages, Raster data compression techniques, Different vector data models	**5**
5.	Digital Elevation Model (DEM), Different derivatives of DEM and their applications, Triangulated Irregular Network (TIN)	**5**
6.	Raster and vector integration, GIS integration with remote sensing	**3**
7.	GIS analysis operations, GIS applications in Earth Sciences	**5**
9.	Errors in GIS and their rectifications, Limitations of GIS	**2**
	Total	**28**

11. Suggested Books:

S. No	Name of Books/ Authors/Publishers	Year of Publication/reprint
1.	*Kennedy, M.l D., " Introducing Geographic Information Systems"*, John Wiley & Sons	2013
2.	Heywood, I., Cornelius S. and Carver S., *"An Introduction to Geographical Information Systems"* (4th Edition), Pearson Prentice Hall.	2012
3.	Chang K., *"Introduction to Geographic Information Systems", McGraw-Hill Education*	2006
4.	Bernhardsen, T., *"Geographic Information Systems: An Introduction"* , John Wiley & Sons	2005
5.	Aronoff, S., *"Geographic Information Systems: A Management Perspective"* WDL Publications	1991
5.		

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-404** Course Title**: Well Logging**
2. Contact Hours : **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs): **Theory: 3** **Practical: 0**
4. Relative Weightage: **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits : **4** 6. 6. Semester: **Spring** 7. Subject Area: **DCC**
8. Pre-requisite: **Nil**
9. Objective: To introduce geophysical well logging techniques for interpretation of subsurface geology

10. Details of course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Objectives of well logging, classification of well logging methods, formation evaluation and its importance	**4**
2.	**Electrical L ogging:** Basic principles, SP log, normal and lateral logs, focused logs, micro-resistivity tools and their role in formation evaluation; Applications	**6**
3.	**Induction L ogs**: Basic principles, dual induction logs, geometric factors; Applications	**6**
4.	**Radiation Logs:** Basic principles of different types of radiation logs including gamma ray, gamma-gamma, neutron thermal and chlorine logs; Porosity determination and cross plots; Applications	**6**
5.	**Sonic L ogs:** Basic principles, sonic logging tools, porosity determination; Applications	**6**
6.	**NMR L ogging:** Permeability, bound and free-water estimation using NMR logging techniques; Applications	**4**
7.	**Auxiliary Logging Devices:** Caliper, dipmeter, cement bond logging, casing collar locators, temperature logging; Applications	**6**
8.	**Integrated an alysis an d i nterpretation of w ell l ogs:** Integrated interpretation of electrical and induction logs, resistivity-porosity, porosity-porosity cross-plot methods of interpretation and field examples	**4**
	Total	**42**

11. **Suggested Books:**

S.No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	Serra, O., "*Well Logging and Geology*", TECHNIP	2003
2.	Theys, P., "*Log Data Acquisition and Quality Control*", Gulf Publishing	1999
3.	Ellis, D.V. and Singer, J.M., "*Well Logging for Earth Scientists*", Elsevier	1987
4.	"*Schlumberger Log Interpretation Principles/ Applications*", Schlumberger Education Services	1987
5.	Lynch, E.J., "*Formation Evaluation*", Harper and Row	1962

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-405** Course Title: **Hydrogeology**
2. Contact Hours: **L: 2** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory: 2** **Practical : 0**
4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**
5. Credits**: 3** 6. Semester**: Autumn** 7. Subject Area**: DCC**
8. Pre-requisite**: Nil**
9. Objective: To introduce fundamental characteristics and distribution of groundwater resources.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Hydrologic cycle, importance of ground water as a resource, residence time, reservoirs, water-balance equation	**3**
2.	**Principles of groundwater Flow:** Basic principles of ground water flow, types of porosities, Darcy's law and its limitations, permeability and hydraulic conductivity, field and laboratory measurements of flow characteristics, problem exercises	**4**
3.	**Occurrence and distribution of groundwater:** Aquifers, confined and unconfined beds, measurement of ground water content, specific yield and retention, geologic formations as aquifers, problem exercises	**5**
4.	**Hydrogeochemical r eactions an d gr oundwater c ompositions:** Equilibrium kinetics, key reactions of ground water chemistry, oxidation-reduction reactions, ion exchange processes, micro-organisms in groundwater, global and Indian water standards	**6**
5.	**Groundwater s ampling and an alysis:** Groundwater sampling and analysis, data plotting and interpretations, groundwater pollution, environmental isotopes in hydrogeology, salt water intrusion, problem exercises	**4**
6.	**Groundwater e xploration:** Geological and geophysical exploration methods, ground water level fluctuations and implications,	**4**
7.	**Groundwater m anagement:** Natural and artificial recharge concepts, site selections for recharge, concepts of groundwater basin management, safe and conjunctive use, groundwater economics	**2**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Fitts, C.R., "*Groundwater Science*", Academic Press	2012
2.	Schwartz, F.W. and Zhang, H., "*Fundamentals of Groundwater*", Wiley Publ.	2008
3.	Todd, D.K., "*Groundwater Hydrology*", 3rd Edition, Willey Publ.	2005
4.	Ward, A.D., and Trimble, S.W., "*Environmental Hydrology*". Lewis Publ.	2004
5.	Domencio, P.A. and Schwartz, F.W., "*Physical and Chemical Hydrogeology*", Wiley Publ.	2002
6.	Clark, I. and Fritz, P., "*Environmental Isotopes in Hydrogeology*", Lewis Publ.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-406** Course Title: **Plate Tectonics**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 2** **Practical: 0**

4. Relative Weightage**: CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0**

5. Credits**: 3** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To introduce the concept of plate tectonics and its importance in understanding the major features on the Earth.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Review of various hypothesis regarding origin of the Earth and solar system	**3**
2	Earth's interior constitution and concept of lithospheric plate. Composition, heat flow, gravity variation in different layers	**2**
3	Oceanic and continental types of Earth's crust, their composition, mineralogy and major structural features	**2**
4	Plate tectonics: Historical background, type of plate margins and sense of displacements of plates	**2**
5	Creative Plate Margin: Composition, seismic structure, magmatic activities and evolution	**2**
6	Conservative Plate Margin: Transforms faults and plate motions, seismicity, structure and evolution	**2**
7	Destructive Plate Margins: Surface manifestations, geophysical and geological characteristics, sedimentological, metamorphic and magmatic characteristics	**4**
8	Orogenesis: Plate tectonics and mountain building processes	**2**
9	Concept of plate tectonics in mineralization and hydrocarbon exploration	**3**
10	Indian Plate: Configuration and characters of Indian plate margins; Himalayan orogeny and tectonic models; Indian seismicity and neotectonics	**6**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Kearey,P., Klepeis, K.A. and Vine, F. J., *Global Tectonics*. John Wiley & Sons Ltd. UK	2013
2.	Condie, K.C., *Plate Tectonics and Crustal Evolution*, Butterworth-Heinemann	2003
3.	Summerfield, M. A., *Geomorphology and Global Tectonics*. John Wiley & Sons Ltd. UK	2000
4.	Davies, G.F., "*Dynamic Earth: Plates, Plumes and Mantle Convection*", Cambridge	2000
5.	Cox, A. and Hart, R. B "*Plate Tectonics: How it Works*", Wiley-Blackwell	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-407** Course Title: **Engineering Geology**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory : 2** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 3** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To impart knowledge on fundamental concepts of Engineering Geology

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction to Engineering Geology, Master Plan for river valley projects	**3**
2.	Dams – parts, types, criteria for site selection, forces acting on dams	**5**
3.	Tunnels – parts, classification, ground conditions, geological considerations	**5**
4.	Engineering Geological mapping for major civil projects	**2**
5.	Engineering properties of rocks – laboratory and field tests	**2**
6.	Concepts of rock mass classification – utilities – RMR scheme	**2**
7.	Landslides – concepts, classification, techniques for analysis	**3**
8.	Building materials – aggregate properties	**2**
9.	Investigations related to highways, buildings, bridges and other structures	**4**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Anbalagan,R. Singh,B, Chakraborthy,D. and Kohli,A. "*A filed Manual for Landslide investigations*". DST, Government of India, New Delhi	2007
2.	Bell, F.G. "*Fundamentals of Engineering Geology*" Elsevier	2007
3.	Gokhale, K.V.G.K. "*Principles of Engineering Geology*" B.S.Publications	2006
4	Krynine, D.P.Judd,W.R. "*Principles of Engineering Geology and Geotectonics*" CBS Publications & Distributors	2001
5.	Singh, B.& Goel, R.K ., `*Rock mass classification: A practical approach in civil Engineering*', Elsevier	1999
6.	Johnson, R.B. and Degraft, J.V. "*Principles of Engineering Geology*" Wiley	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-409** Course Title: **Petroleum Geology**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 2** **Practical: 0**

4. Relative Weightage: **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **DCC**

8. Pre-requisite: **Nil**

9. Objective: To introduce subsurface structural mapping techniques for petroleum exploration

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: definitions, peak oil, oil depletion protocol, OPEC, Super majors, world oil reserve/production, five magic ingredients	**4**
2.	Chemistry of petroleum, saturated/unsaturated hydrocarbons, composition and classification of crude, price benchmarking	**4**
3.	Petroleum genesis, organic vs. inorganic theories, types of organisms in ocean layers, world carbon cycle, petroleum through geologic age	**3**
4.	Biomass to petroleum, diagenesis, catagenesis, metagenesis, kerogen, thermal maturation of kerogen	**3**
5.	Migration, primary/secondary/tertiary migration, mechanism of primary migration	**2**
6.	Reservoir, sedimentary rock classification, porosity, permeability, reservoir fluid dynamics, , bouncy vs. capillary pressure	**3**
7.	Traps, classification, timing of trap formation vis-à-vis trap formation, total petroleum system	**4**
8.	Petroleum exploration, geological/ geophysical/geochemical methods, reserve estimation, drilling methods	**5**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Bjørlykke, K.. "*Petroleum Geoscience: From Sedimentary Environments to Rock Physics*", Springer	2010
2.	Gluyas, J and Swarbrick. R., "*Petroleum Geoscience*". Blackwell.	2004
3.	Selley, R. C., *Elements of Petroleum Geology*, (Second edition), Academic Press	1998
4.	Tissot, B. P. and D H Welte, D. H., "*Petroleum Formation and Occurrence*", Springer-Verlag.	1984
5.	Levorsen, A. I., "*Geology of Petroleum*", Second edition, W.H. Freeman (Reprinted by CBS Publishers)	1967

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-421** Course Title: **Numerical Modelling in Geophysics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To teach the various modeling techniques

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Role of Numerical Modeling in Geophysics	**2**
2.	Interpolation/Extrapolation Techniques	**6**
3.	Root Finding Methods, Quadratute Methods	**6**
4.	Matrix Equation Solvers: Direct, Iterative, Semi-iterative	**8**
5.	Methods for Eigenvalue/Eigenvector Evaluation	**4**
6.	Partial Differential Equation Solvers: FDM, FEM, IEM	**12**
7.	Simulation & Experiment Design Techniques	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Schilling RJ, Harries SL, "*Applied numerical Methods for Engineers*", Thomson Asia Pvt. Ltd, Singapore	2002
2.	Press WH, Teulosky SK, Vellerling WT, Flannery BP, "*Numerical Recipes in Fortran*", Cambridge University Press	1992
3.	Golub GH, van Loan CF, "*Matrix computations*", Johns Hopkins University Press	1989
4.	Chapra SC, "*Applied numerical methods with MATLAB*", Tata-McGraw Hill	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-422** Course Title: **Geophysical Inversion**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: ES-421: Numerical Modelling in Geophysics**

9. Objective: To teach the various data inversion techniques used in geophysics

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to forward and inverse problems in geophysics	**2**
2.	Formulation of various inverse problems in geophysics, reduction to a matrix equation, linear inverse problem, solution of inverse problem	**5**
3.	The least square, minimum norm and Marquardt solutions of a matrix equation, overdetermined and underdetermined problems, weighted least squares and weighted damped least squares solution	**5**
4.	The singular value decomposition of the matrix, generalized inverse, application to geophysical problems	**5**
5.	The Rao-Mitra generalized inverse, solution of a general system of equations, applications to geophysical inversion.	**4**
6.	Computational aspects of various matrix inversion methods: Linearization and parameterization, advanced inversion methods	**6**
7.	Linear regularization methods: Backus-Gilbert inversion method; Tikhonov's regularization method, computational aspects and applications	**5**
8.	Introduction to non-linear inversion methods: non-linear inverse problems, convergence and non-uniqueness of non-linear problems, maximum entropy methods	**6**
9.	Examples of solution of inverse problems from literature	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Menke W, "*Geophysical Data Analysis: Discrete Inverse Theory MATLAB Edition*", Academic Press	2012
2.	Tarantola, A., "*Inverse Problem Theory*", SIAM Publication	2005
3.	Press WH, Teulosky SK, Vellerling WT, Flannery BP, "*Numerical Recipes in Fortran*", Cambridge University Press	1992
4.	Golub GH, van Loan CF, "*Matrix computations*", Johns Hopkins University Press	1989

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-423** Course Title: **Geophysical Well Logging**

2. Contact Hours : **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs) : **Theory:3** **Practical:0**

4. Relative Weight age: **CWS:15** **PRS:15** **MTE:30** **ETE:40** **PRE:0**

5. Credits:**4** 6. Semester: **Autumn** 7. Subject Area: **DCC**

8. Pre-requisite: Knowledge of Different methods of exploration geophysics

9. Objective: To impart the role of Well logging in exploration geophysics, including hydrocarbon, mineral and groundwater studies. Special emphasis to be laid on formation evaluation problems of hydrocarbon exploration.

10. Details of Course:

S. No	Content	Contact Hours
1.	Introduction, Objectives of geophysical well logging, general classification of well logging methods, formation evaluation – its importance and applications, different well logging softwares for formation evaluation	**8**
2.	Electrical logging –Both focused and unfocussed tools (Normal, Lateral and SP logs), micro-resistivity tools and their role in formation evaluation	**6**
3.	Induction logging; Concept of departure curves and geometric factors; Porosity, permeability, water and oil saturation estimation based on electrical logging measurements	**8**
4.	Porosity logs – Neutron, density, neutron and sonic logs; Individual departure curves for environmental corrections. Cross plots for determination of Lithology, fluid type, saturations and mineral identification of rock matrix. Assessing the influence of clay/ shale content on porosity estimations	**10**
5.	NMR technique for permeability, bound and free-water estimations; Well-bore seismics	**4**
6.	Auxiliary logging devices – caliper, dipmeter, cement bond logging, casing collar locators, temperature logging	**4**
7.	Wire line sampling – rock sampling, fluid sampling and pressure measurements; Geological applications of well logging	**2**
	Total	**42**

List of practicals:

1. Open hole wireline log data. Understanding of header information, different track data and related details
2. Qualitative interpretation of integrated well log data – Identification of permeable formations for possible hydrocarbon accumulation
3. Introduction to resistivity departure curves and their applications – Estimation of resistivities of mud, mud-cake and mud filtrate at borehole temperature of perspective strata
4. Processing of resistivity, SP, Gamma ray, Dual Induction log and porosity log data
5. Formation evaluation of integrated well log data for clean sands
6. Formation evaluation of integrated well log data for shaly sands (Waxman – Smits model)
7. Formation evaluation of integrated well log data for carbonate rocks

11. Suggested Books:

S. No.	Name of Books/ Authors/ Publishers	Year of Publication /reprint
1.	Serra, O. "*Well logging and geology*", Editions TECHNIP	2003
2.	Theys, P. "*Log data acquisition and quality control*", Gulf Publishing Co.,	1999
3.	Ellis, D.V. and Singer, J.M "*Well logging for earth scientists*", Elsevier	1987
4.	Schlumberger "*Log Interpretation Principles/ Applications*". Schlumberger Education Services, Houston, Texas.	1987
5.	Serra, O "*Fundamentals of Well Log Interpretation, Vol. 1. The Acquisition of Logging Data*", Elsevier, Amsterdam	1984
6.	Lynch, E. J "*Formation Evaluation*", Harper and Row	1962

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-424** Course Title: **Petroleum Geosciences**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory :3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: (Spring)** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To introduce subsurface structural mapping techniques for petroleum exploration

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: definitions, peak oil, oil depletion protocol, OPEC, Super majors, world oil reserve/production, five magic ingredients	**6**
2.	Chemistry of petroleum, saturated/unsaturated hydrocarbons, composition and classification of crude, price benchmarking	**6**
3.	Petroleum genesis, organic vs. inorganic theories, types of organisms in ocean layers, world carbon cycle, petroleum through geologic age	**4**
4.	Biomass to petroleum, diagenesis, catagenesis, metagenesis, kerogen, thermal maturation of kerogen	**4**
5.	Migration, primary/secondary/tertiary migration, mechanism of primary migration	**4**
6.	Reservoir, sedimentary rock classification, porosity, permeability, reservoir fluid dynamics, , bouncy vs. capillary pressure	**4**
7.	Traps, classification, timing of trap formation vis-à-vis trap formation, total petroleum system	**6**
8.	Petroleum exploration, geological/ geophysical/geochemical methods, reserve estimation, drilling methods	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Bjørlykke, K.. "*Petroleum Geoscience: From Sedimentary Environments to Rock Physics*", Springer	2010
2.	Gluyas, J and Swarbrick. R., "*Petroleum Geoscience*". Blackwell.	2004
3.	Selley, R. C., *Elements of Petroleum Geology*, (Second edition), Academic Press	1998
4.	Tissot, B. P. and D H Welte, D. H., "*Petroleum Formation and Occurrence*", Springer-Verlag.	1984
5.	Levorsen, A. I., 1967, "*Geology of Petroleum*", Second edition, W.H. Freeman (Reprinted by CBS Publishers)	1967

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-442** Course Title: **Mineral Economics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical :0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DEC – III/IV**

8. Pre-requisite**:**

9. Objective: To provide knowledge of mineral industry and its socio-economic role with special reference to India.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Mineral economics and its concept and its inherent specialties, concept of Mineral resources and reserves estimation	**8**
2.	Mineral legislation	**4**
3.	Economics of Mineral Exploration and Problems related to Infrastructure, Production, Processing; Effect of co-products and byproducts	**8**
4.	Marketing and trade, Demand Analysis, Market Survey, Consumption and Substitution	**8**
5.	Mineral taxation and incentives, Pricing of minerals, Conservation and substitution; Strategic, critical and essential minerals	**8**
6.	Mineral industry and its impact on environment, National Mineral Policy	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Wellmer, F. W., Manfred, D., Markus, W., *Economic Evaluations in Exploration* , Springer Verlag	2008
2.	Chatterjee.K.K., *An Introduction to Mineral Economics*, New Age International	2004
3.	Wellmer, F. W., *Statistical Evaluations in Exploration for Mineral Deposits*, Springer Verlag	1998
4.	Sinha,R.K., and Sharma, N.L., *Mineral Economics*, Oxford & IBH Pub. Co.	1988
5.	Govett, G.J.E., and Govett, M.H., *World Mineral Supplies*, Elsevier Scientific Pub. Co.	1976

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-444** Course Title: **Indian Mineral Deposits**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE :25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DEC – III / IV**

8. Pre-requisite**: Nil**

9. Objective: To provide concepts on occurrence, geology, geochemistry and genesis of important economic mineral deposits of India.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction and distribution of various mineral deposits in India with special reference to crustal evolution and metallogeny	**5**
2.	Mineralogy, classification, mode of occurrence, geochemistry and genesis of bauxite, iron and manganese deposits	**8**
3.	Types, characteristics and geological setting of copper, lead-zinc, chromite, tin and tungsten deposits.	**10**
4.	Geology, pattern of mineralization, genetic models of gold, silver and platinum deposits, current exploration scenario in India	**7**
5.	Nature and distribution of mica, magnesite, bentonite, baryte limestone and phosphate deposits of India	**5**
6.	Geological controls, occurrence and reserves of coal and petroleum in India	**5**
7.	Importance of mineral deposits in national economy	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication / Reprint
1.	Sarkar, S. and Gupta, A. "*Crustal evolution and Metallogeny in India*", Cambridge University Press	2011
2.	*Indian Minerals Yearbook,* Part I and II, IBM Publications	2007
3.	Talapatra, M., "*Modeling and Exploration of Mineral Deposits*", Capital Publishing	2006
4.	Prasad, U. "*Economic Geology*", CBS publishers	1996
5.	Banerjee, D.K. "*Mineral Resources of India*", The World Press	1992

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-446** Course Title: **Precambrian Tectonics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical: 2**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DEC – III / IV**

8. Pre-requisite**: Nil**

9. Objective: To provide basic knowledge of Archaean and Proterozoic Tectonics.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Archaean stratigraphy of classical Kaapvaal Craton, Pilbara Craton and Isua Greenstone Belt	**6**
2.	Archaean stratigraphy of the five cratons in India: Singhbhum Craton, Bastar Craton, Bundelkhand Craton, Aravalli Craton, Dharwar Craton	**6**
3.	Comparison of the Vertical and Horizontal tectonic models proposed for different Archaean Cratons	**5**
4.	When did Plate Tectonic Begin: Archaean or Proterozoic?	**5**
5.	Classic Proterozoic Mobile Belts of the World	**6**
6.	Proterozoic Mobile Belts in India	**8**
7.	Destruction of Archaean Cratons: Craton-Craton collision, Craton-Mobile Belt collisions, some case studies	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Ramakrishnan, M. and Vaidyanadhan, R., "*Geology of India*", Volume-1, Geological Society of India, Bangalore,	2008
2.	Condie, K. and Pease, V., "*When did Plate Tectonics Begin on Planet Earth*?", Geological Society of America	2008
3.	Van Kranendonk, M.J., Smithies, R.H. and Bennett, V.C., "*Earth's Oldest Rocks*", Elsevier	2007
4.	Burg, J. P., "*Orogeny through time"*, Geological Society London	1997
5.	Condie, K. C., "*Archaean Crustal Evoloution"*, Elsevier	1994

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-448** Course Title: **Advanced Remote Sensing**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory3** **Practical 0**

4. Relative Weightage**: CWS:15 PRS:15 MTE:30 ETE:40 PRE:0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DEC – III/IV**

8. Pre-requisite**: ES-401: Principles of Remote Sensing**

9. Objective: To provide advanced knowledge of remote sensing techniques of data acquisition, processing and interpretation with suitable examples from geosciences.

10. Details of Course:

S. No	Particulars	Contact Hours
1.	Blackbody radiation principle and atmospheric interaction, ground interaction including selective reflection, absorption and emission of radiation	**4**
2.	Spectra of mineral groups and igneous, sedimentary and metamorphic rocks in optical and thermal-IR parts of the spectrum	**4**
3.	Orbits and satellites, field data/ground truth	**2**
4.	Digital scanner systems and cameras, factors affecting sensor performance, types of sensor resolutions, status of space-borne sensors	**5**
5.	Geometric distortions in image data, factors affecting radiometric quality of image data	**4**
6.	Principle of image interpretation in the solar reflection region	**2**
7.	Thermal infra-red sensing and interpretation; apparent thermal inertia mapping, temperature estimation; spectral emmissvity mapping	**4**
8.	Advanced techniques of image data correction, enhancement and classification; multi-image data integration	**5**
9.	Hyperspectral sensing, microwave sensors, SAR image data interpretation, SAR interferometry	**6**
10.	Geological applications in geomorphology, structure, lithology and resources exploration	**6**
	Total	**42**

List of Practicals

1. Familiarization with various types of image and photo products, Image Processing software – ERDAS, ENVI, ILWIS.
2. Collection of spectra of igneous, sedimentary and metamorphic rocks and various natural objects in the field using spectro-radiometer.
3. Visual image interpretation, image interpretation elements and image interpretation key.
4. Image enhancement, feature reduction and digital image classification.
5. Structural, lithological and geomorphological mapping using satellite images; application approaches in exploration.

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	James B. Campbell and Randolph H. Wynne *"Introduction to Remote Sensing"*, 5th Ed., The Guildford Press, New York	2011
2.	Lillesand, T.M., Kiefer, R.W. and Chapman, J.W., "*Remote Sensing and Image Interpretation*", 5th Ed., John Wiley & Sons	2007
3.	Sabins, F.F. Jr., "*Remote Sensing-Principles and Interpretation*", Freeman and Co, .	2007
4.	Jensen, J. R., "*Introductory Digital Image Processing*", Prentice Hall.	2007
5.	Gupta, R. P., "*Remote Sensing Geology*", 2nd Ed., Springer	2003
6.	Drury, S. A., "*Image Interpretation in Geology*", 2nd Ed, Allen & Unwin	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPTT /CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN-450** Course Title: **Advanced Geographic Information Systems**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory:3** **Practical : 0**
4. Relative Weightage **CWS** 15 **PRS** 15 **MTE** 30 **ETE** 40 **PRE** 0
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **DEC – III / IV**
8. Pre-requisite: **ES-403: Principles of Geographic Information Systems**
9. Objective of Course: To impart advanced knowledge of GIS Technology its integration with Remote Sensing and GPS and applications to earth sciences
10. Details of Course:

S. No	Content	Contact Hours
1.	Different co-ordinate systems, various data models in GIS, concept of 'no data'.	**6**
2.	Spaghetti, Polygon, DIME vector data models, construction of topology; its requirements and limitations.	**5**
3.	Various types of digital elevation models (DEM), its derivatives, DEM based Surface hydrologic modelling and applications, DEM applications in quantitative geomorphology.	**8**
4.	Advanced GIS analysis: network, neighbourhood, weighted overlay, different types of buffering techniques, change detection.	**8**
5.	Classification methods in GIS, modelling in GIS.	**4**
6.	Precision and accuracy, errors in GIS, their detection and optimization.	**3**
7.	Concept of global positioning system (GPS), differential GPS, GPS applications in Earth Sciences, GPS integration with GIS and remote sensing.	**8**
	TOTAL	**42**

List of Practical:

1. Familiarization with various GIS software
2. Georeferencing of scanned maps, satellite images, fly-through projection etc. image to map, map to map and image to image rectifications
3. Vector data generation / digitization and topology construction
4. Deriving various standard DEM derivatives and surface hydrologic modeling for watershed characteristic and stream networks
5. Performing various GIS analysis functions / operations, classification of continuous data by various methods and their comparisons
6. Utilization of various standard models e.g. USLE, SWAT, MODFLOW etc. in GIS
7. Field utilization of GPS & differential GPS and integration / applications of GPS data into remote sensing and GIS

11. Suggested Books:

S. No	Name of Books / Authors / Publishers	Year of Publication /Reprint
1.	Heywood, I., Cornelius, S. and Carver, S., "*An Introduction to Geographical Information Systems*" 4th Ed.	2012
2	Tomlinson, R., "*Thinking About GIS: Geographic Information System Planning for Managers*" 3rd Ed., ESRI Press	2008
3.	El-Rabbany, A., "*Introduction to GPS: The Global Positing System*", 2nd Ed., Artech House	2006
4.	Maguire, D., Michael, B. and Michael, G., "*GIS, Spatial Analysis, and Modeling*", ESRI Press	2005
5.	Michael, D. N., "*GIS Modeling in Raster*", John Wiley & Sons Inc.	2001

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-452** Course Title: **Advanced Engineering Geology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DEC – III / IV**

8. Pre-requisite**: ES-407: Engineering Geology**

9. Objective: To impart knowledge on various investigations carried out for evaluating river valley projects and other major engineering structures

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction for general Engineering Geological investigations and limitations	**2**
2.	Systematic investigations for dams – reconnaissance, Detailed, Pre-construction and Construction investigations	**6**
3.	Water pressure tests at dam site Equipments, procedures, calculations and interpretation of results	**6**
4.	Environmental Impacts of Dams & Reservoirs	**4**
5.	Tunneling problems and support requirements for tunnel excavations	**6**
6.	Geophysical investigations for river valley projects	**4**
7.	Foundation treatments for dams	**4**
8.	Explosives and their applications	**4**
9.	Landslide analysis and corrective measures	**4**
10.	Coastal Hazards and management	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Anbalagan, R. Singh, B, Chakraborthy,D. and Kohli,A. "*A field Manual for Landslide investigations*". DST, Government of India, New Delhi	2007
2.	Bell, F.G., "*Engineering Geology*" Butterworth & Heinemann	2007
3.	Singh, B.& Goel, R.K., "*Rock mass classification: A practical approach in Civil Engineering*", Elsevier	2002
4.	Krynine, D.P.Judd,W.R. "*Principles of Engineering Geology and Geotectonics*" CBS Publications & Distributors	2001
5.	Waltham, T. "*Foundations of Engineering Geology*", Spon Press, London	1999
6.	Johnson, R.B. and Degraft, J.V. "*Principles of Engineering Geology*" Wiley	1988

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-454** Course Title: **Marine Geology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DEC – III / IV**

8. Pre-requisite**: Nil**

9. Objective: To introduce fundamentals of Marine Geology regarding ocean and their evolution through time.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Marine Geology:** Introduction, land sea distribution, world's major oceans, origin of ocean, theory of plate tectonics, sea floor spreading, Wilson cycle, growth of ocean basins.	**3**
2.	**Ocean Basin morphology**: Configuration, theories of ocean basin formation, major oceanic features	**4**
3.	**Oceanic Crust:** Structure, petrology and sources of oceanic crust	**4**
4.	**Deep-Sea Sediments an d P rocesses:** Deep-sea sediments and their relation to oceanic processes such as solution, productivity, and dilution	**6**
5.	**Sea l evel C hanges an d s tratigraphy:** Sea level changes and their consequence, sea level history during Phanerozoic	**4**
6.	**Physical O ceanography:** Methods of measuring properties of sea water. Salt composition and residence time; dissolved gases in seawater	**6**
7.	**Ocean ci rculation:** The Ocean Conveyor belt and its role in controlling world's climate. Surface circulation; concept of mixed layer, thermocline and pycnocline, Coriolis Force and Ekman Spiral, Upwelling, El nino; processes affecting biological productivity of ocean margin waters	**8**
8.	**Ocean R esources:** Mineral resources of the ocean including polymetalic nodules. Techniques for deep se exploration. Marine Gas Hydrates and their economic potential	**3**
9	**Marine P ollution:** Marine Pollution emphasizing geochemical aspects of the sources, transport, and fate of pollutants in the coastal marine environment	**2**
10	**Nation building Strategies:** Laws of sea, Indian coasts and special economic zone; concept to find appropriate deep sea location to dispose nuclear and other hazardous waste	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Erickson. J., "*Marine Geology: Exploring the New Frontiers of the Ocean*", Infobase Publishing	2009
2.	Kuenen, H, "*Marine Geology*" Read Books Publishers	2008
3.	Seibold, E and Berger, W. H., "*The Sea Floor: An Introduction to Marine Geology*" Springer.	1996
4.	Heinemann, B., "*The Ocean Basins: Their Structure and Evolution: Their Structure and Evolution*" Butterworth	1998
5.	Kennet.J. P., "*Marine Geology*" Prentice-Hall	1982

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-471** Course Title: **Geotechnical Investigations**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical :0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – III / IV**

8. Pre-requisite**: Nil**

9. Objective: To acquaint with surface and subsurface geotechnical investigations

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction to geotechnical investigations for river valley projects	2
2.	Master plan for river valley projects - types of river valley projects, criteria for selection and systematic methodology for site selection	6
3.	Systematic investigations & foundation evaluation for dams –reconnaissance, detailed, pre-construction and construction stage investigations	7
4.	Tunnel excavation techniques; Problems of tunnel excavation; Support requirements of tunnels; Systematic investigations for tunnels	7
5.	Geophysical investigations for river valley projects for dams tunnels and landslide investigations	5
6.	Engineering properties of rocks, laboratory & field tests	3
7.	Investigations for evaluation of construction materials	4
8.	Investigations for landslide analysis	4
9.	Investigations related to highways, buildings, bridges and other structures	4
	Total	42

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint

1.	West, T.R., "*Geology applied to Engineering*", Waveland Pr. Inc.	2010
2.	Bell, F.G., "*Engineering Geology*", Butterworth & Heinemann	2007
3.	Anbalagan,R. Singh,B, Chakraborthy,D. and Kohli,A. "*A field Manual for Landslide investigations*". DST, Government of India, New Delhi	2007
4.	Waltham, T. "*Foundations of Engineering Geology*", Spon Press, London	2002
5.	Krynine, D.P and Judd, W.R., "*Principles of Engineering Geology and Geotechnics*", CBS Publishers & Distributors	2001
6.	Singh, B.& Goel, R.K . "*Rock mass classification: A practical approach in civil Engineering*", Elsevier	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-472** Course Title: **Advanced Seismology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: VIII (Spring)** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**:** **ES-325: Seismology**

9. Objective: To introduce advanced level ideas of Seismology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Earthquake kinematics and dynamics:** One-dimensional Haskel source, source spectrum, stress drop, particle velocity, rupture velocity, magnitude scales revisited, seismic energy and magnitude, aftershock and fault area, scaling and earthquake self similarity, earthquake statistics.	**8**
2.	**Seismic waveform modeling:** Body and surface waveform modeling for seismic source, source time function and fault slip, complex earthquakes, very broadband seismic source model.	**6**
3.	**Free oscillation:** Spheroidal, toroidal and radial modes of oscillation, mode attenuation, splitting and coupling.	**6**
4.	**Anisotropic Earth structure:** General considerations, transverse isotropy, azimuthal anisotropy, anisotropy of minerals and rocks, anisotropy of composite structures, anisotropy of lithosphere, asthenosphere, mantle and core.	**6**
5.	**Attenuation and elasticity:** Wave attenuation, geometric spreading, multipathing, scattering, intrinsic attenuation, quality factor Q, spectral resonance peaks, physical dispersion due to anealsticity, physical models for anelasticity, Q from crust to core.	**8**
6.	**Seismotectonics:** Divergent boundaries, transcurrent boundaries, convergent boundaries, intraplate earthquakes, earthquake cycle, earthquake prediction.	**4**
7.	**Seismic hazard zonation:** Probabilistic hazard zonation, hazard and risk, seismic microzonation using microtremor data	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Havskov, J. and·Ottemöller, L., "*Routine Data Processing in Earthquake Seismology*", Springer.	2010
2.	Shearer, P.M., "*Introduction to Seismology*", Cambridge Univ. Press.	2009
3.	Schuster, G., "*Seismic Interferometry*", Cambridge Univ. Press.	2009
4.	Nolet, G., "*A Breviary of Seismic Tomography: Imaging the Interior of the Earth and Sun*", Cambridge Univ. Press.	2008
5.	Pujol, J., "*Elastic Wave Propagation and Generation in Seismology*", Cambridge Univ. Press.	2003
6.	Stein, S. and Wysession, M., "*An Introduction to Seismology, Earthquakes and Earth Structure*", Blackwell Publishing.	2003
7.	Aki, K. and Richards, P.G., "*Quantitative Seismology*", Univ. Science Books.	2002
8.	Udias, A, "*Principles of Seismology*", Cambridge Univ. Press.	1999
9.	Sato, H. and Fehler, M.C., "*Seismic Wave Propagation and Scattering in the Heterogeneous Earth*", AIP Press Springer.	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-473** Course Title: **Magnetotelluric and Geomagnetic Depth Sounding**
2. Contact Hours : **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs) : **Theory:3** **Practical:0**
4. Relative Weight age: **CWS:25** **PRS:0** **MTE:2** **ETE** **PRE:0**
5. Credits:4 6. Semester: **VII (Autumn)** 7. Subject Area: **DEC – III / IV**
8. Pre-requisite: **ES-322: Electromagnetic Prospecting**
9. Objective: Impart the knowledge of Magnetoteluric and geomagnetic depth sounding. Various theoretical and practical aspects related to shallow and deep exploration problems.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Frequency range in primary natural electromagnetic field, generation of natural electromagnetic field, their structure in time and space.	**4**
2.	General physical principles of the magnetotelluric (MT) and geomagnetic soundings. Schematic models of primary magnetotelluric source field, linear algebraic relationships between the components of magnetotelluric field, magnetotelluric impedance, admittance and magnetic induction arrows. Impedance of a plane wave in 1D earth, Cagniard-Tikhonov fundamental model of the MT problem, definitions of apparent resistivity, recurrence relations. 1D forward and inverse solution of 1D MT problem.	**10**
3.	Concept of Magetotelluric impedance tensor, impedance polar diagram impedance invariants, directionality and dimensionality of impedance tensor. Spatial characteristics of impedance and apparent resistivity for TE and TM modes.	**6**
4.	Practical aspects of MT and geomagnetic depth sounding, instrumentation, field procedure, site setup, recording parameters, on line and off line data processing, estimation of impedance tensor. Robust processing of MT data and interpretation.	**8**
5.	Separation of the local and regional MT effects, various methods for impedance decomposition. Multi-dimensional modeling and inversion of MT data, case studies	**4**
6.	Geomagnetic depth sounding methods, concept of induction arrows in different convention, GDS response function and superposition model.	**6**
7.	Recent trend and aase studies	**4**
	Total	**42**

List of Practicals:

1. MT data acquisition parameters and file format.

2. MT site set up and data recording for single site and remote reference mode
3. Study of the characteristics of time series and noise identification
4. Time series processing using various public domain codes
5. 1D and 2D MT modeling using WingLink
6. 1D and 2D inversion using WingLink
7. Experiment of grid optimum grid design and 3D modeling using WingLink
8. Interpretation of real field data using WinGlink

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	*The Magnetotelluric methods, Theory and practice* Edited by Alans D. Chave and Alans G. Jones	**2012**
2.	*Models and methods of Magnetotelluric* By Mark N. Berdichevsky and Vladimir I. Dmitriev	**2008**
3.	*Practical Magnetotellurics* By Fiona Simpson and Karsten Bahr	**2005**
4.	Oristaglio, M. J. and Spies, B.R.: 1999, '*Three Dimensional Electromagnetics*', in M. J. Oristaglio and B. R. Spies (eds.), Three Dimensional Electromagnetics, S.E.G. Geophysical Developments Series 7	**1999**
5.	*Mathematical methods for Geo-Electromagnetic Induction* by J. T. Weaver John Wiley & Sons Inc.	**1994**
6.	Nabighian, M (ed.s) *EM methods in Applied Geophysics (Vol 1 & 2)* SEG Publications	**1987**
7.	*The Magnetotelluric sounding method* By Kaufman, A. A. and Keller, G. V. Elsevier Amsterdam	**1981**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-474** Course Title: **Advanced Electromagnetic Prospecting**

2. Contact Hours : **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs) : **Theory3** **Practical0**

4. Relative Weight age: **CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits:**4** 6. Semester: **VIII (Spring)** 7. Subject Area: **DEC – V / VI**

8. Pre-requisite: **ES-322: Electromagnetic Prospecting**

9. Objective: Impart the knowledge of advanced electromagnetic methods of geophysical exploration applied in near surface earth, borehole, marine and airborne environment.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	The Magnetometric resistivity ((MMR) method: MMR response of a layered earth, MMR anomaly and model responses.	**6**
2.	Drill-Hole induction methods: Dipole-dipole EM method, borehole EM method with remote source, method of interpretation and field example.	**6**
3.	Airborne Electromagnetic methods: Classification of time and frequency domain airborne EM methods, Field operation and data recording. Airborne EM data processing and interpretation. Time-domain, towed-bird AEM survey. Large scale AEM mapping case studies.	**10**
4.	Seafloor EM methods: Marine magnetotellurics, controlled source frequency and time domain marine EM methods. Case studies..	**8**
5.	Models and method in Electromagnetic: Study of the EM responses of different earth models e.g. vertical fault and dyke model. Algorithms for forward response computation using frequency and time stepping. Model response calculations for two-dimensional and three-dimensional structure.	**12**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books/ Authors/ Publishers	Year of Publication /reprint
1.	Alans D. Chave and Alans G. Jones (Ed.) *The Magnetotelluric methods, Theory and practice*	2012
2.	Mark N. Berdichevsky and Vladimir I. Dmitriev *Models and methods of Magnetotelluric*	2008
3.	Fiona Simpson and Karsten Bahr *Practical Magnetotellurics*	2005
4.	Oristaglio, M. J. and Spies, B.R.: (eds.), *Three Dimensional Electromagnetics*, S.E.G. Geophysical Developments Series 7	1999
5.	J. T. Weaver *Mathematical methods for Geo-Electromagnetic Induction* John Wiley & Sons Inc.	1994
6.	Nabighian, M (ed.s) *EM methods in Applied Geophysics* (Vol 1 & 2) SEG Publications	1987
7.	Kaufman, A. A. and Keller, G. V. *The Magnetotelluric sounding method* Elsevier Amsterdam	1981

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-475** Course Title: **Digital Image Processing**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PR: E0**

5. Credits**:4** 6. Semester**: VII (Autumn)** 7. Subject Area**: DEC-III /IV**

8. Pre-requisite**: Nil**

9. Objective: To teach the mathematical basis of algorithms employed in Digital Image Processing

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction	**2**
2.	Digital Image Fundamentals	**6**
3.	Image Enhancement Techniques	**6**
4.	Image Restoration Techniques	**6**
5.	Colour Image Processing	**6**
6.	Wavelets and Multiresolution Processing	**6**
7.	Image Compression Algorithms	**6**
8.	Morphological Image Processing, Image Segmentation	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1	Starck JL, Murtagh F, Fadill JM, *Sparse image and signal processing*, Cambridge University Press	2010
2.	Siarry P (Ed), *Optimization in signal and image processing*, John Wiley	2007
3.	Gonzalez RC, Woods RE, *Digital Image Processing*, Pearson Education Asia	2002
4.	Richards JA, *Remote sensing Digital Image Analysis*, Springer Verlag	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN- 476** Course Title**: Synthetic Seismograms**

2. Contact Hours : **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. 6. Semester: **VIII (Spring)** 7. Subject Area**: DEC – V / VI**

8. Pre requisite: **ES-325: Seismology and ES-324: Seismic Prospecting**

9. Objective**:** To introduce application of **s**ynthetic seismogram in oil prospecting and seismic hazard studies

10. Details of Course:

S. No.	Contents	Contact Hours
1.	An overview about the role of synthetic seismogram in oil prospecting and seismology, various techniques of generating synthetic seismogram for different sources	**2**
2.	Parameters required for generating synthetic seismogram, Gernalised Hook's law and constitutive equation and its role in modeling various subsurface earth structures, VTI media, elastic parameters for representing layered earth model, crystal symmetry and anisotropy	**5**
3.	Characteristics of reflection process, Normal incidence synthetic seismogram for layered earth media, Use of constitutive equation and boundary condition to generate synthetic seismogram, application of finite element method for generating synthetic seismogram	**6**
4.	Synthetic seismogram from well-log data, staggered algorithm and its role in generating synthetic seismogram, leap frog algorithm for generating synthetic seismogram, generation of synthetic seismogram for marine data	**6**
5.	Methods for generating synthetic seismogram under different seismic source and receiver conditions i.e., receiver at surface and source buried, receiver buried and source at surface, receiver and source both buried, Derivation of expression for Christofell equation, generation of synthetic seismogram for earthquake source,	**6**
6.	Understanding the anisotropy, velocity anisotropy terminology for geophysicist, weak elastic anisotropy, Thomsen parameters, derivation of various Thomsen parameters, Use of Thomsen parameters in the interpretation of seismic data, role of Thomsen parameter in the generation of synthetic seismogram	**6**

7.	Seismic ray tracing for minimum time path, derivation of ray equation from wave equation, derivation from Fermat's principle, numerical solution of ray equation, initial value and boundary value formulation of ray equation, unified approach for finding solution of ray equation, turning point depth, understanding ray trajectories in media with different velocity distributions, ray in sphere, generation of synthetic seismogram using ray tracing technique	**6**
8.	Application of technique of generating synthetic seismogram in seismic prospecting, application of synthetic seismogram in seismic hazard prediction, case studies for land seismic survey, case studies for Marine seismic survey, case studies of synthetic seismogram of some well known earthquakes	**5**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Books/ Authors/Publishers**	**Year of Publication /reprint**
1.	Aki K. and Richards, P.G., "*Quantitative Seismology*", University Science Books.	2002
2.	Enders, A. R., "*Seismic Inversion and Deconvolution*", Elsevier Science Pub Co.	1999
3.	Lay, T., Wallace, T.C., "*Modern Global Seismology*", Academic Press.	1995
4.	Kenneth, H. W., "*Reflection seismology: A Tool for energy resource exploration*", Krieger Publishing.	1992
5.	Yilmaz, O., "*Seismic Data Processing*", Society of Exploration Geophysicists.	1987
6.	Robort E. Sheriff, *Seismic Stratigraphy*, Springer.	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN-477** Course Title**: Strong Motion Seismology**

2. Contact Hours : **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS: 25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits:**4** 6. Semester: **VII (Autumn)** 7. Subject Area**: DEC – III / IV**

8. Pre requisite: **ES-325: Seismology**

9. Objective**:** To introduce basic concept of strong motion seismology, numerical simulation techniques of strong ground motion, practical application of strong motion data in seismology and earthquake engineering

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Basic concept of strong motion seismology, characterization of strong motion data, study of some Indian strong motion earthquakes	**4**
2.	**Parameters of Strong Ground Motion:** Characterization of strong and weak ground motion, principles of instruments used for their recording, study of various parameters of strong ground motion like peak ground acceleration, duration, predominant period.	**4**
3.	**Processing of Strong Ground Motion:** Technique used to record strong ground motion, processing of strong motion data, linear correction, instrumental correction, band pass filtering, methods of selection of low corner of band pass	**4**
4.	**Effect of Strong Ground Motion on Structure:** Vibration of single degree of freedom system, various cases of free vibration, forced vibration of a damped system, dynamic amplification and phase relationship for various system, response of building to earthquake ground motion, Duhamel integral	**6**
5.	**Attenuation relations:** Method of computing attenuation relations, study of various parameters used in defining attenuation relations, study of various constraints of attenuation relation	**4**
6.	**Earthquake Source Model:** Role of earthquake source spectra used in strong motion studies, Brune's model, Atkinson'S model, Barrier model, Huddon's model	**4**
7.	**Seismic hazard :** Deterministic and probabilistic approach for seismic hazard zonation, Cornell's approach of probabilistic	**4**

	hazard, GSHAP and its relevance	
8.	**Stochastic Si mulation of St rong Ground M otion:** Various parameters required for synthetic generation of strong ground motion, Stochastic simulation technique-its advantage and limitations, case study of some well known earthquakes	**4**
9.	**Empirical G reen's F unction T echnique:** Generation of synthetic strong ground motion using Empirical Green's Function technique, Self similarity laws of source and spectral parameters, Derivation of expression for EGF technique starting from first principle, advantage and limitation of Empirical Green's function technique, case study of some well known earthquakes	**4**
10.	**Semi e mpirical Technique:** method of simulation of strong ground motion, its advantages and disadvantages, case study for some well known earthquakes	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication/ Reprints
1.	Bolt, B.A., "*Earthquake 5th edition*", W.H. Freeman & Co.	2003
2.	Aki, K., and Richards, P.G., "*Quantitative Seismology*", University Science Books.	2002
3.	Kramer, S.L., "*Geotechnical Earthquake Engineering*", Prentice Hall.	1996
4.	Bullen, K. and Bolt, B.A., "*An Introduction to the Theory of Seismology*", Cambridge University Press.	1987
5.	Erdik, M.O. and ToksÖz, M.N., "*Strong ground motion Seismology*", Springer.	1987
6.	Bolt, B.A., "*Strong Motion synthetics (Computational techniques, Vol. 4)*", Academic press.	1987

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-478** Course Title: **Environmental and Engineering Geophysics**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs) : **Theory:3** **Practical:0**
4. Relative Weightage: **CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**
5. Credits:**4** 6. Semester: **Spring** 7. Subject Area: **DEC – V / VI**
8. Pre-requisite: Knowledge of different methods of exploration geophysics
9. Objective of Course: To impart recent geophysical techniques for solving site investigation and environmental problems of near surface of earth

10. **Details of Course:**

S. No.	Contents	Contact Hours
1.	Introduction, role of recent geophysics advances in solving major civil engineering site investigation and environmental problems pertaining to soil and groundwater	**2**
2.	Microgravity data acquisition, processing and interpretation. Applications illustrated by case studies– Underground cave detection, mapping of fractures, shear zones, site selection for underground disposal of nuclear and hazardous material, prediction of rock bursts in underground mine shafts	**5**
3.	High-resolution magnetic surveys in mapping underground pipes, intrusives, mapping basement, identifying unexploded mines, buried drums and tanks and archeological site mappings illustrated by case studies	**5**
4.	Geoelectrical imaging (2-D, 3-D and 4-D), basic theory including inversion algorithms, Case studies highlighting several civil engineering site characterization problems, dam site suitability and leak detection and underground contaminate leachate tracking	**7**
5.	Spectral Induced Polarization method, theory and applications	**4**
6.	Georadar (2-D and 3-D), physical principles, theory, data processing and interpretation. Applications with case studies – underground utility mapping in urban environment, unexploded mine detection and ordinance mapping, groundwater table mapping, prediction of lithological sections at project sites	**6**
7.	High resolution seismics in near surface applications, marine seismics for location of basement below sea bottom for offshore civil engineering constructions and harbour needs. Cross-hole seismic tomography in tunnel site investigations.	**5**

8.	Multi-channel analysis of surface waves (MASW) – theory, processing and interpretation. Dispersion curve. shear wave velocity depth section and estimation of stiffness depth profile. Case studies highlighting rippability studies, voids or cave detection, shallow basement mapping, soil classification and aiding geotechnical site characterization	**8**
	Total	**42**

List of Practicals:

1. Handling resistivity and IP imaging equipment
2. Resistivity and IP imaging data processing
3. Resistivity and IP imaging data interpretation
4. Georadar data acquisition procedures
5. Georadar data processing
6. Georadar data interpretation
7. Handling Seismic refraction unit
8. Handling high-resolution reflection seismic unit
9. Seismic data acquisition, processing and interpretation

11. Suggested Books:

S.No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	Burger H.R., Sheehan A.F., Jones C.H., " *Introduction to applied geophysics: Exploring the shallow subsurface*", W.W. Norton, N.Y	2006
2.	Milson J., "*Field geophysics (Geological field guide)*", John Wiley& Sons, UK	2003
3.	Kearey P., Brooks M., Hill I., "*An introduction to geophysical exploration*", Wiley-Blackwell	2002
4.	Sharma P.V., " *Environmental and engineering geophysics*", Cambridge University Press	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-545** Course Title: **Mineral Technology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory 3** **Practical0**

4. Relative Weightage**: CWS:25** **PRS: 0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-305: Economic Geology and ES-304: Ore Geology**

9. Objective: To impart basic knowledge on ore/mineral beneficiation techniques based on physical properties of ore and gangue minerals and their influence on metallurgy.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to the principles of ore/mineral dressing and application to various deposits	**4**
2.	Application of ore microscopy in mineral technology	**4**
3.	Crushing and crushers, concept of liberation of grains sizing and grinding, different types of mills, screening and classification application of microscopy	**8**
4.	Heavy-liquid separation, jigging and tabling	**6**
5.	Flocculation and dispersion, floatation process: different aspects – physical, chemical, mineralogical parameters; floatation circuits, flotation of polymetallic ores	**6**
6.	Magnetic separation and other concentration processes	**4**
7.	Separation of solid from fluid and auxiliary operations	**4**
8.	Selected case studies of ore/mineral beneficiation in India: copper, lead-zinc, iron, manganese ores and coal	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	NPCS Board of Consultants and Engineers, "*The Complete Technology Book on Minerals and Mineral Processing*", Asia	**2008**

	Pacific Business Press Inc.	
2.	Wills, B., "*Mineral Processing Technology: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery*", Butterworth-Heinemann	**2006**
3.	Gupta, A. and Yan D., "*Mineral Processing Design and Operation: An Introduction*", Elsevier Science and Technology	**2006**
4.	Fuerstenau, M. C., Kenneth, N. H., "*Principles of Mineral Processing*", Society for Mining Metallurgy and Exploration	**2003**
5.	Somasundaran, P., Moudgil, B. M. "*Reagents in Mineral Technology*", M. Dekker	**1987**
6.	Gaudin, A.M., "*Principles of Mineral Dressing*", McGraw-Hill Education	**1939**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-547** Course Title: **Isotope Geology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical: 0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-206: Igneous Petrology and ES-303: Metamorphic Petrology**

9. Objective: To impart various aspects of Isotope Geology and geochronology and their application in the study of evolution of earth and terrestrial planets.

10. Details of Course:

S.No.	Contents	Contact Hours
1	Basics of geochronology/isotope geology	**4**
2	Sample preparation and ion chromatography, Isotopic dilution mass spectrometry	**8**
3	Principles of mass-spectrometry, types of mass-spectrometer for geochronology/ isotope geology and their uses,	**6**
4	Rb-Sr Systematics for geochronology and its importance in igneous petrogenesis, dating of fabric, water system, paleontology	**4**
5	Sm-Nd system, isochron dating, modal ages, εNd and their uses in crustal processes	**4**
6	U-Th-Pb dating technique	**4**
7	Concept of closure temperature and Exhumation of terrains	**2**
8	Cosmogenic nuclides, new frontiers in isotope geology	**4**
9	Lu-Hf and other lithophile isotope system	**2**
10	Geochemistry of radiogenic isotopes for evolution of Earth	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Claude, A. C., and Allegre, C. Sutcliffe "*Isotope Geology*", Cambridge University Press,	2009
2.	Dickin, A.P. "*Radiogenic Isotope Geology*" Cambridge University Press,	2005
3.	Faure, G. and Mensing, T. M., "*Isotopes: Principles and Applications*" John Wiley, New York	2004
4.	Rollinson, H., "*Using geochemical data: evolution, presentation, interpretation*" Pearson Education Limited	1993
5.	Faure, G., "*Principles of Isotope Geology*", John Wiley	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-549** Course Title: **COAL GEOLOGY**
2. Contact hours: **L : 3** **T : 1** **P : 0**
3. Examination duration (hrs): **Theory:3** **Practical : 0**
4. Relative weightage: **CWS:25** **PRS:0** **MTE: 25** **ETE:50** **PRE:0**
5. Credits:**4** 6. Semester: **Autumn** 7. Subject Area: **DEC – V / VI**
8. Pre-requisite**: Nil**

9. **Objective:** To impart knowledge on various aspects of formation, occurrence and distribution of coal

10. Details of course:

Sl. No.	Contents	Contact hours
1.	Types, physical properties, rank & grade and classifications of coal	4
2.	Microscopic study of coal, macerals and microlithotypes	4
3.	Chemical characterization: proximate and ultimate analysis; trace elements in coal	3
4.	Coal petrography, microscopic constituents of coal, vitrain, clairen, durain and fusain; sapropylic coal;	4
5.	Application of coal petrology in solving industrial and geological problems	2
6.	Origin of coal, allochthonous and autochthonous theories; origin of Gondwana and European coal formation	4
7.	Origin of peat swamps, climatic, palegeographic and tectonic requirements; depositional models of coal bearing sequence	3
8.	Diagenesis of peat and coalification- causes, role of time, temperature; physical changes associated with increased coal rank	3
9.	Combustion, gasification, carbonisation and coke and hydrogenation	2
10.	Gondwana and Tertiary coal deposits	2
11.	Distribution of coal in space and time in the world; geology of important coalfields of India	5
12.	Coal mining and Industrial use of coal; coal as a source rock for hydrocarbons	6
	TOTAL	**42**

11. <u>Suggested Books:</u>

Sl. No.	Name of Books/Authors/Publishers	Year of publication /reprint
1.	Suarez-Ruiz et al.: "*Applied coal petrology*". Elsevier	2008
2.	Thomas L.: "*Coal Geology*", John Wiley and Sons Inc	2002
3.	Harder, V. M., R. P., Alexander, C. H., James, C. P., Douglas: "*Atlas of Coal Geology: Coal Geology and Coal Petrology*", American Association of Petroleum Geologists (AAPG)	1998
4.	Douglas, C. P.: "*Geology in Coal Resource Utilization*", American Association of Petroleum Geologists	1991
5.	Ward, C. R.: "*Coal Geology and Coal Technology*", Blackwell Scientific Publications	1985
6.	Ross, C. A. and Ross, June R. P.: "*Geology of Coal*", Hutchinson Ross Pub. Co.	1984
7.	Tatsch, J.H.: "*Coal Deposits* ", Tatsch Associates	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-551** Course Title: **Micropaleontology & Paleoceanography**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory :3** **Practical: 0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-203: Paleontology and ES-204: Stratigraphy**

9. Objective: To introduce fundamentals of Micropaleontology and Paleoceanography

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Micropaleontology and its application in solving Geological Problem:** Surface and subsurface sampling; sample processing techniques and equipments	**8**
2.	**Calcareous Microfossils:** Planktic Foraminifera, Benthic Foraminifera, Larger Foraminifera, Nannofossils, Osctracoda, Pteropoda, Calpionellids and Calcareous Algae. Their modern biogeography, outline of morphology, surface ultrastructure. Significance in Cenozoic oceanic biostratigraphy and application in paleoceanographic and Paleoclimatic study .	**12**
3.	**Siliceous Microfossils:** Radiolaria, Diatoms and silicoflagellates**:** Outline of morphology. Modern biogeography. Application in Oceanography and environmental studies	**6**
4.	**Phosphatic Microfossils:** Conodonts. Outline of morphology, biological affinities and paleoecology.	**2**
5.	Application of Micropaleontology in Petroleum Exploration	**4**
6.	**Paleoceanography:** Approaches to Paleoceanographic reconstructions; general outline of DSDP, ODP and IODP; deep sea drilling vessels; evolution of oceans during late Phanerozoic; opening and closing of gateways; evolution of ocean during Paleozoic Era; application of stable isotopes in paleoceanography	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Sinha, D.K.. *Micropaleontology: Application in Stratigraphy and Paleoceanography,* Alpha Science International, Oxford & Narosa Publishing House Pvt. Ltd. Delhi.	2007
2.	Kennett and Srinivasan, 1983. *Neogene Planktonic Foraminifera: Aphylogenetic Atlas,* Hutchinson Ross, USA.	2004
3.	Fischer, G and Wefer, G,. *Use of Proxies in Paleoceanography: Examples from the South Atlantic*, Springer.	1999
4.	Jones, R. W., 1996. *Micropaleontology in Petroleum exploration*, Clarendon Press Oxford.	1998
5.	Tolmazin, D_1985. *Elements of Dynamic Oceanography,* Allen and Unwin	1985
6.	Haq and Boersma, 1978. *Introduction to Marine Micropaleontology*, Elsevier..	1983
7.	Braiser, M.D., *Microfossils,* Geogrge Alien and Unwin Publisher.	1980.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-553** Course Title: **Global Environment**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE :25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: Nil**

9. Objective: To understand the various aspects of global environment

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Origin of Earth, geologic history, differentiation processes and formation of core, mantle, crust, atmosphere and biosphere,	**2**
2.	**Air E nvironment:** Atmosphere, composition, general climate patterns, feedback mechanisms, global climate changes, environmental impact assessment, global case studies	**8**
3.	**Water E nvironment:** Hydrosphere, oceans, rivers, lakes, glaciers and groundwater, water composition and distribution, continental water pollution, marine water pollution, environmental impact assessment, case studies	**8**
4.	**Land E nvironment:** Soil and sediment compositions, degradation, land ecology, prey-predator models, land-use changes, environmental impact assessment, case studies,	**8**
5.	**Energy Resources:** Various energy sources, green energy, sustainable energy environment and development, case studies	**8**
6.	**Environmental L aws:** Global environmental laws, Environmental laws in India, Environmental auditing, Land and coastal zone management, case studies	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Schlesinger, W.H. and Bernhardt, E.S. "*Biogeochemistry: An Analysis of Global Change*", Associated Press, 3rd Ed.	2013
2.	Berner, E.K. and Berner, R.A., "*Global Environment: Water, Air and Geochemical Cycles*", Prentice-Hall Publ. 2nd Ed.	2012
3.	Anderson, D.A., " *Environmental Economics and Natural Resources Management*", Routledge Publ.	2010
4.	Ruddimann, W.F., "*Earth's Climate*", Freeman Publ.	2008
5.	Last, W.M. and Smol, J.P., "*Tracking environmental change using lake sediments*", Kluwer Publ.	2008
6.	Drever, J.I., "*The Geochemistry of Natural Waters*", Prentice-Hall Publ., 3rd Ed.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-555** Course Title: **Shear Zone Metasomatism**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical: 0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: Nil**

9. Objective: To provide basic knowledge of shear zone metasomatism.

10. Details of Course:

S.No.	Contents	Contact Hours
1	Introduction to shear zones: Brittle, Brittle-Ductile and Ductile Shear Zones	**8**
2	Deformation mechanisms in different types of shear zones and mescoscopic structures	**6**
3	Shear Zone microstructures	**5**
4	Fluid flow in shear zones	**5**
5	Chemical and mineralogical changes during shear zone formation: Some important case studies	**6**
6	Application of non-equilibrium thermodynamics in understanding shear zone processes	**6**
7	Case studies from different shear zones in India	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davis, G.H., Reynolds, S.J., Kluth, C.F., " *Structural Geology of Rocks and Regions*", 3rd Edition, John Wiley & Sons,	2012
2.	Prior, D.J., Rutter, E.H. and Tatham, D.J., " *Deformation Mechanisms, Rheology and Tectonics*, Geological Society	2011
3.	Passchier, C.W. and Trouw, R.A.J., "*Microtectonics*", Springer-Verlag, Germany	2005
4.	Gapais, D., Brun, J.P., Cobbold, P.R., " *Deformation Mechanisms, Rheology and Tectonics: From Minerals to Lithosphere*", Geological Society	2005
5.	Vernon, R.H., "*A Practical Guide to Microstructure*", Cambridge University Press	2004
6.	Alsop, G.I., Holdsworth, R.E., McCaffrey, K.J.W., Hand, M., "*Flow Processes in Faults and Shear Zones*", Geological Society Special Publication -224	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Earth Sciences**

1. Subject Code: **ESN-557** Course Title: **Theory of application of Mohr circle**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-301: Structural Geology-II**

9. Objective: To introduce the concept of Mohr circle and its application to the stress and strain analyses in rocks.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Homogeneous stress, stress vectors and their resolution.	**4**
2.	**Theoretical p rinciples:** Mathematical derivation and theoretical implications of Mohr circle.	**6**
3.	**Graphical representation:** Representation of various types of stress states and tensors by Mohr cirlce	**2**
4.	**Fracture an alysis:** Derivation of the criteria for different types of neofractures and their representation on Mohr circle.	**6**
5.	**Reactivation of f ractures:** Theory of reactivation of pre-existing geological discontinuities and criteria for frictional sliding. Effect of orientation of anisotropy in frictional sliding.	**6**
6.	**Concept of s train:** Strain tensor- theory, geometrical descriptions and Mohr circle representations.	**6**
7.	**Application of M ohr c ircle in s train anal ysis:** strain estimation through Mohr circle using various types of strain markers	**6**
8.	**Pole to Mohr circle:** principle and geological applications	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Ragan, D. M., "*Structural Geology*", IVth Edn., Cambridge Universtiy Press, UK.	2009
2.	Twiss, R.J. and Moores, E.M., "*Structural Geology*", 2nd Edn, W. H. Freeman and company, NY.	2007
3.	Ramsay, J. G. and Lisle, R. J., ``*Techniques of Modern Structural Geology, Vol. 3, Application of Continuum Mechanics in Structural Geology*``, Academic Press, London.	2000
4.	Ramsay, J. G. and Huber, M. I., ``*Techniques of Modern Structural Geology, Vol. 1, Strain Analysis*``, Academic Press, London.	1983
5.	Means, W. D., ``*Stress and Strain: Basic Concepts of Continuum Mechanics for Geologists*``. Springer-Verlag, NY.	1976

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-559** Course Title: **Advance Stress and Strain Analysis**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-301: Structural Geology-II**

9. Objective: Theory and application of methods for estimation of paleostress and paleostrain in rocks.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Principles of paleostress analysis	4
2.	**Stress i ndictors:** Geometry and Mechanics of development of various stress indicators in rocks	4
3.	**Graphical m ethods:** Various graphical methods for paleostress determination in rocks.	6
4.	**Numerical m ethods:** Principles and application of inversion methods for estimation of reduced stress tensor in rocks	6
5.	**Strain an alysis:** Theory, concepts and significance of strain analysis	6
6.	**Shape a nalysis methods:** Various methods based on the geometry of strain markers in the rocks	6
7.	**Retrodeformational m ethods:** strain estimation by retrodeformation of rocks.	4
8.	**Point di stribution M ethods:** Strain estimation in rocks using methods based on various types point distribution in rocks.	6
	Total	42

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Fossen, H., `` *Structural Geology*``. Cambridge University Press. Lond.	2010
2.	Ragan, D. M., "*Structural Geology*", IVth Edn., Cambridge Universtiy Press, UK.	2009
3.	Twiss, R.J. and Moores, E.M., "*Structural Geology*", 2nd Edn, W. H. Freeman and company, NY.	2007
4.	Passchier, C. W. and Trouw, R. A., ``*Microtectonics*``. Springer, NY.	2005
5.	Ramsay, J. G. and Lisle, R. J., ``*Techniques of Modern Structural Geology, Vol. 3, Application of Continuum Mechanics in Structural Geology*``, Academic Press, London.	2000
6.	Ramsay, J. G. and Huber, M. I., ``*Techniques of Modern Structural Geology, Vol. 1, Strain Analysis*``, Academic Press, London.	1983

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-561** Course Title: **Quaternary Geosciences**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory3** **Practical0**
4. Relative Weightage**: CWS:25 PRS:0 MTE:25 ETE:50 PRE:0**
5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**
8. Pre-requisite**: Nil**
9. Objective: To understand the present Geological processes and to interpret the past with reference to present

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Quaternary Era and its significance in Earth Science; Neogene-Quaternary boundary	**3**
2.	Quaternary Climatic changes, Glaciation and deglatciation and their effect	**4**
3.	Quaternary Paleogeography and landscape developments	**4**
4.	Pleistocene sea level change and its significance in marine and non-marine depositional environments	**4**
5.	Quaternary Tectonism (Neotectonics) and its significance in geomorphology and sedimentation	**5**
6.	Global Quaternary deposits; Quaternary Geological processes in the Indo-Gangetic plains	**4**
7.	Quaternary deposits in Peninsular India and Coastal Plains	**6**
8.	Quaternary Geochronology: Luminescence chronology, Radiocarbon chronology, Dendrochronology their applicability and problems	**6**
9.	Earth's magnetism in Quaternary Era	**2**
10.	Quaternary geology in planning and Engineering problems	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication /Reprint
1.	Dawson, A.G., *Ice Age Earth: Late Quaternary Geology and Climate,* Abingdon, Oxon	2013
2.	Grapes, R. H. Grigelis, A. ⁊Oldroyd D., History of Geomorphology and *Quaternary Geology,* Geological Society of London, Special Publication-301	2008
3.	Tiwari, M.P. and Mohabey, D. M., *Quaternary of India*, Gondwana Geological Magazine	1999
4.	Zhisheng, A. and Zhou, W., *Quaternary Geology*, VSP BV The Netherland	1997
5.	Mulder, F.J. De and and hageman, B. P., *Applied Quaternary Research* Balkema, Brookfield	1989
6.	Mahaney, W.C., *Quaternary dating Methods*, Elseiver	1984

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-563** Course Title: **Fluid Inclusions: Methods and Applications**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC – V / VI**

8. Pre-requisite**: ES-305: Economic Geology and ES-304: Ore Geology**

9. Objective: To provide concepts and impart knowledge on fluid inclusions in minerals, importance in understanding geological processes and applications in geosciences.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, nature and occurrence of fluid inclusions	**5**
2.	Sample selection and preparation; fluid inclusion petrography	**5**
3.	Basic principles of thermometric analysis involving pressure-temperature diagrams	**5**
4.	Practical aspects of heating- freezing techniques	**7**
5.	Presentation and interpretation of fluid inclusion data	**7**
6.	Decrepitating technique, laser Raman spectroscopy and crush-leach methods	**6**
7.	Application of fluid inclusions in mineral exploration,, tectonics, sedimentary environments and hydrocarbon exploration	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors / Publishers	Year of Publication/ Reprint
1.	Samson, I., Anderson, A and Marshall, D. *Fluid Inclusions, Analysis and Interpretation*, Mineralogical Association of Canada, Short Course Series, Vol. 32	2003
2.	Benedetto, D. V. and Freezzoti, M., "*Fluid Inclusions in Minerals. Methods and Applications*", International Mineralogical Association Special Publication	1997
3.	Nesbitt, V., "*Short course on fluids in tectonically active regimes of the continental crust*", Mineralogical Association of Canada.	1990
4.	Shepherd, T., Rankin, A. H. and Alderton, D.H.M., "*Fluid Inclusion Studies*", Blackie	1985
5.	Roedder, E. "*Fluid Inclusions*", Reviews in Mineralogy, Volume 12, Mineralogical Society of America	1984

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-565** Course Title: **Structural Geology for Petroleum Exploration**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory : 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC V / VI**

8. Pre-requisite**: Nil**

9. Objective: To introduce subsurface structural mapping techniques for petroleum exploration

10. Details of Course:

S. No.	Contents	Contact Hours
1.	The doctrine of subsurface mapping and its use in petroleum explorations, types of maps and subsurface maps and cross sections	**2**
2.	Structural cross sections, stratigraphic cross sections, correlation sections, 3-D views	**4**
3.	Fault maps, displacement, throw, vertical separation; fault maps on seismic lines; types of fault patterns	**4**
4.	Contouring: guidelines, methods, faulted surfaces, short cuts, seismic and well data integration	**6**
5.	Isopach maps, sand/shale distribution, vertical thickness determination, net pay, reservoir volume determination, interval isopach maps	**6**
6.	Structural interpretation of seismic, gravity, electromagnetic maps	**6**
7.	Cross section balancing; dip-domain mapping, depth to detachment calculation, kinematics of fault-fold relations, restoration, section balancing in compressional and extensional terrains, effects of internal strain	**12**
8.	Petroleum system modelling	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication /reprint
1.	Kearey, K., Brooks, M. and Hill, Ian, "*An Introduction to Geophysical Exploration*", 3rd Edition, Wiley	2013
2.	Assaad, F., LaMoreaux, P. E. and Hughes, T. H. (eds.), "*Field methods for Geologists and Hydrologists*", Springer	2009
3.	Groshong R. H., "*3-D Structural Geology*", 2nd Edition, Springer	2006
4.	Mukhopadhyay, D. K., "*Structural geology for petroleum geoscientists*", Association of Petroleum Geologists, India	2006
5.	Shaw, J. H., Christopher, C. and Suppe, J., "*Seismic interpretation of contractional faut-related folds*", Studies in Geology, American Association of Petroleum Geologists	2005
6.	Tearpock, D. J. and Richard E. Bischke R. E., "*Applied Subsurface Geological Mapping with Structural Methods*", 2nd Edition, Printice	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code**: ESN-571** Course Title: **Reservoir Geophysics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs) : **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS: 0** **MTE:25** **ETE:50** **PRE:0**

5. Credits:**4** 6. Semester: **Autumn** 7. Subject Area: **DEC – VII / VIII**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of application of Geophysical Technology to oil and gas fields development and exploitation.

10. Details of Course:

S. No.	Contents	Contact hours
1 .	Reservoir management, reservoir description, role of geophysics in reservoir management, predevelopment phase, initial development phase, operating phase, enhanced oil recovery phase.	**5**
2 .	Synergism, synergism and organization, management philosophy, reservoir system, reservoir simulation, forecasting, decision and decision making.	**6**
3 .	Reservoir management using 3D seismic data, types of 3D data, timing of data acquisition, data acquisition, data processing and data interpretation, geometric framework, rock properties, hydrocarbon indicators	**4**
4 .	Interpretation of 3D data, amplitude, phase and color, interactive interpretation, seismic inversion and shear properties, borehole studies, time lapse measurements	**6**
5 .	A.V.O, elastic waves and rock properties, AVO equations, processing sequence for AVO analysis, derivation of AVO attributes by pre-stack amplitude inversion, interpretation of AVO attributes, 3D AVO analysis	**8**
6 .	Acoustic impedance estimation, synthetic sonic logs, processing sequence for acoustic impedance estimation, derivation of acoustic impedance attributes, 3D acoustic impedance estimation, instantaneous attributes, VSP, seismic anisotropy.	**8**
7 .	Mathematical foundation of elastic wave propagation, wave propagation phenomena, the Zoeppritz equation, pre-stack amplitude inversion, 4D seismics	**5**
	Total	**42**

11. Suggested books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	J.H. Schon, "*Physical Properties of Rocks*", Elsevier	2004
2.	Sheriff , R.R. (ed) "*Reservoir Geophysics*" Society of Exploration Geophysicists	1999
3.	Castagna, J.P. and Backus, M.M. (eds) "*Offset Dependent Reflectivity- Theory and Practice of AVO Analysis*", Society of Exploration Geophysicists	1992
4.	S. Edward, (Ed.) "*Mathematics in Oil Production* ", Oxford University Press	1988
5.	G.D. Hobson (Ed.) "*Modern Petroleum Technology*", John Wiley and Sons	1987

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-573** Course: **Geotomography**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs): **Theory:3** **Practical:0**

4. Relative weightage: **CWS:25** **PRS:0** **MTE:25** **ETE :50** **PRE:0**

5. Credits:**4** 6. Semester: **Autumn** 7. Subject Area: **DEC – VII/VIII**

8. Pre-requisite: **Nil**

9. Objective: To introduce tomographic techniques used in geophysical exploration.

10. Details of the Course:

S. No.	Contents	Contact Hours
1.	Introduction: Tomography genesis & necessary definitions, Elements of functional analysis; mathematical spaces, mappings, tomographic problems as mappings between mathematical spaces, Frechet's derivative, contraction mapping theorem and its application, ill-posed inverse problems and Tikhonov's method of regularization	**7**
2.	Medical tomography and numerical solvers, simultaneous iterative reconstruction technique adoption to geotomographic problems, conjugate gradient methods, numerical solvers for non-linear equations, sparse matrix solvers	**8**
3.	Reconstruction from projections, radon transform	**5**
4.	Seismic tomography, basics of seismic travel time tomography, Seismic refraction & reflection time and waveform tomography	**5**
5.	Seismic topographic methods, cross-hole tomography, seismic forward and inversion algorithms, 4D Seismics and seismic time lapse measurements in enhanced oil recovery operations	**6**
6.	Electrical resistivity tomography, electrical charge accumulation concepts, efficient approximate forward modelling algorithms, application of resistivity tomography in environmental impact assessment (EIA), multi-electrode experiments including mobile ones	**5**
7.	SP tomography and imaging of mineral deposits, micromagnetic surveys & tomography in EIA	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books/ Authors/Publishers	Year of Publication /reprint
1.	Anderson, D.L., "*New theory of earth*", Cambridge University Press.	2009
2.	Scales,J.A., "*Theory of seismic imaging*", Springer-Verlag, Inc., N.Y.	1995
3.	Golub,G.H., Van Loan,C.F., "*Matrix computations*", John Hopkins University press.	1989
4.	Tarantola,A., "*Inverse problem theory*", Elsevier.	1987
5.	Nolet,G., "*Seismic tomography*", D.Reidel Publication Co.	1987
6.	Herman, G.T., "*Image reconstruction from projection: The fundamentals of computerized tomography*", Academic Press, Inc.	1980

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-575** Course Title: **Geophysical Fluid Dynamics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical : 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE:50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC- VII/ VIII**

8. Pre-requisite**: Nil**

9. Objective: To teach the basics of fluid flow phenomena in ocean and atmosphere

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Geophysical Fluid Dynamics	**2**
2.	Corliolis Force, Equations Governing Geophysical Fluid Flows	**6**
3.	Diffusive and Advective Processes	**6**
4.	Rotation Effects: Geostrophic Flows, Vortivity Dynamics, Ekman Layer, Barotropic Waves and Instability	**6**
5.	Stratification Effects: Stratification, Layered Models, Internal Waves	**6**
6.	Dynamics of Stratified Rotating Flows, Fronts, jets and vortices etc.	**6**
7.	Atmospheric and Oceanic General Circulation	**6**
8.	Equatorial Dynamics	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Canuto C, Hussaini MY, Quarteroni A, Zang A, *Spectral methods. Applications to fluid dynamics*, Springer Verlag	2007
2.	Cushman-Roisin B, Beckers J-M, *Introduction to geophysical fluid dynalics: physical and numerical aspects*, Academic Press	2005
3.	Kundu PK, Cohen IM, *Fluid Mechanics*, Academic Press	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-577** Course Title: **Advanced Techniques in Geophysical Exploration**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE: 25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC-VII/ VIII**

8. Pre-requisite**: Nil**

9. Objective: To deal with modern techniques in various exploratory geophysical techniques

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Amplitude vs. offset studies	**6**
2.	Braodband electromagnetic methods, Ground penetrating Radar	**8**
3.	Swept impact seismic technique, Spectral Analysis of surface waves, MASW and SASW	**10**
4.	High resolution marine seismic, Audio MT survey	**9**
5.	Shallow VSP imaging, microgravity surveys	**9**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Mark Berdichevsky and Vladimir I. Dmitriev; "*Models And Methods of Magnetotellurics*", Springer	2008
2.	Burger H.R., Sheehan A.F., Jones C.H., " *Introduction to applied geophysics: Exploring the shallow subsurface*", W.W. Norton	2006
3.	Gadallah, M.R. and Fisher, R.L., "*Applied Seismology, A Comprehensive Guide to Seismic Theory and Application*", PennWell.	2005
4.	Emery, W. and Thomsen, R., "*Data Analysis methods in Physical Oceanography*", Elsevier	2004
5.	Milson J., "*Field geophysics (Geological field guide)*", John Wiley& Sons	2003
6.	Bleistein N. Cohen, J.K, and Stockwell, J.W. "*Mathematics of Multidimensional Seismic Imaging, Migration, and Inversion*", Springer	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-579** Course Title: **Dynamic Systems in Earth Sciences**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DEC-VII/VIII**

8. Pre-requisite**: Nil**

9. Objective: To introduce the concepts of fractal geometry and its applications in Earth Sciences.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Mathematical background, self similarity, Sierpinski triangles, Koch curves, cantor sets	**4**
2.	Box-counting dimensions, Kolmogrov capacity, 1D and 2-D box counting	**6**
3.	Hausdorff measures and dimension, deterministic and random fractals, natural fractals, iterated Function Systems, stochastic dynamical systems, compression of images	**8**
4.	Dynamical systems, interval self-mappings, complex iteration, perturbation theory, geometrical theory, small divisors, deterministic chaos to deterministic division	**10**
5.	Fractals in earth science, various applications in fragmentation, tectonics, geomorphology, seismology	**9**
6.	Applications to other Fields, image compression, finance, soil mechanics	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Schroeder, M., "*Fractals, Chaos, Power Laws: Minutes from an infinite paradise",* Dover	2009
2.	Ott, E., "*Chaos in Dynamical Systems*", Cambridge Univ. Press, 2nd ed.	2005
3.	Falconer, K., "*Fractal Geometry: Mathematical Foundations and Application*" , Wiley .	2003
4.	Sprott, J. C., "*Chaos and Time Series Analysis*", Oxford Univ. Press	2003
5.	Turcotte, D.E., "*Fractals and Chaos in Geology and Geophysics*", Cambridge Univ Press	1997
6.	Peitgen, H., Jurgens, H., Saupe, D., Maletsky, E. M., Perciante, T. and Yunker, L. E, "*Fractals for the Classroom*", Springer Verlag	1992

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Earth Sciences**

1. Subject Code: **ESN-581** Course Title: **Advanced Seismic Prospecting**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical :0**

4. Relative Weightage**: CWS:25** **PRS:0** **MTE:25** **ETE:50** **PRE:0**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DEC-VII/ VIII**

8. Pre-requisite**:** **ES-324: Seismic Prospecting**

9. Objective: To introduce advanced level ideas of Seismic Prospecting.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Seismic Migration:** Exploding reflector model, Kirchoff migration, WKB migration, downward continuation method, finite difference migration, frequency-wavenumber migration	**9**
2.	**Seismic Stratigraphy:** Problems encountered during interpretation of reflections seismic data, structural and stratigraphic traps and their seismic representation, correlation of reflection seismic data with depositional environment of sedimentary rocks.	**9**
3.	**Direct Detection of Lithology and Hydrocarbon:** Non-uniqueness of results obtained from seismic reflection, inversion of reflection data, lithology change indicators, hydrocarbon indicators, seismic attributes.	**8**
4.	**Amplitude Variation With Offset:** Relation with pore fluid type, approximations of Zoeppritz equation; Bortfeld's, Shuey's, Wiggin et al.'s and Smith and Gidlow's approximation of Zoeppritz's equation and related amplitude variation with offset attributes.	**8**
5.	**Rock Physics in Seismic Interpretation:** Relationship between seismic wave velocity and properties of rocks and pore fluid.	**4**
6.	**Vertical Seismic Prospecting:** Basic concepts, field setup, source and receiver characteristics, types of noises and their removal, advantages of VSP data.	**4**
	Total	**42**

11. Suggested Books**:**

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davies, R.J., Posamentier, H.W., Wood, L.J. and Cartwright, J.A. (eds), "*Seismic Geomorphology: Applications to Hydrocarbon Exploration and Production*", Geological Society, London, Special Publications.	2007
1.	Davies, R.J., Cartwright, J.A., Stewart, S.A., Lappin, M. and Underhill, J. R. (eds), "*3D Seismic Technology: Application to the Exploration of Sedimentary Basins*", Geological Society London Memoir 29.	2004
3.	Brown, A.R., "*Interpretation of Three-Dimensional Seismic Data*", Published jointly by The American Association of Petroleum Geologists and the Society of Exploration Geophysicists.	2004
4.	Yilmaz, O., "*Seismic Data Analysis – Processing, Analysis and Interpretation of Seismic Data*", SEG Publication.	2001
5.	Scales, J.A., "*Theory of Seismic Imaging*", Samizdat Press.	1997
6.	Gadallah, M.R., "*Reservoir Seismology*", PennWell Books.	1994
7.	Robinson, E.A., Durrani, T.S. and Peardon, L.G., "*Geophysical Signal Processing*", Prentice-Hall International.	1986
8.	Sheriff, R.E., "*Seismic Stratigraphy*", The English Book Depot	1982

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Name of the Department /Centre: **Department of Hydrology**

1. Subject Code: **HYN-102** Course Title: **Engineering Hydrology**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**: CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**:ESC**

8. Pre-requisite**: Fundamental science**

9. Objective: To impart knowledge of various components of hydrological processes, measurements and analysis of variables involved and subsequent applications.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Introduction**: Hydrologic cycle, processes and budget; Fundamentals of hydrometeorology, Indian monsoon system	**3**
2.	**Frequency Analysis**: Random variables, Probability distribution functions: normal, log-normal, Gumbel, Pearson type-3 uniform distributions; Frequency analysis; Goodness of fit measures.	**4**
3.	**Precipitation Measurement and Analysis**: Precipitation variability, rainfall and snow measurement techniques, design of precipitation gauging network, consistency of rain record, filling up of missing record, estimation of mean areal rainfall, IDF and DAD analysis, Snow measurement and estimation of snow melt.	**6**
4.	**Hydrologic Abstractions:** Interception and depression storage; Evaporation: factors affecting, measurement and estimation; Evapotranspiration: measurement and estimation; Infiltration, factors affecting infiltration, measurement of infiltration, empirical and analytical models of infiltration; Rain harvesting: procedures and design.	**6**
5.	**Stream Flow**: Runoff process: measurement of stream flow, factors affecting stream flow; Stage-discharge relationship; Peak discharge estimation; hydrograph analysis, base flow separation, unit hydrograph for stream flow estimation, synthetic unit hydrograph, hydrological modeling.	**8**
6	**Watershed Management:** Watershed and its characteristics; Curve number method; Soil erosion and estimates; Watershed management techniques, Erosion control.	**4**

7.	**Groundwater H ydrology:** Types of aquifers; Flow and storage parameters; Well hydraulics; Groundwater flow modeling, Hydrogeological and geophysical surveys; Groundwater quality, Contaminant transport modeling; Sea water intrusion.	**7**
8.	**Flood R outing:** Governing equations, Reservoir flood routing, Hydrologic routing: Muskingum method.	**4**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Chow, V.T., Maidment, D.R. and Mays, L.W.: Applied Hydrology, Mc Graw Hill	1998
2.	Mays, L.W.: Water resources Engineering, John Wiley and Sons	2001
3.	Singh V.P., Elementary Hydrology, Prentice Hall of India	1994
4.	Subramanya, K., Engineering Hydrology, 4th Edition, Tata Mc Graw Hill	2013
5.	C.W. Fetter, Applied Hydrogeology, Fourth Edition, CBS Publishers and Distributors, New Delhi, 2001	2001
6.	H.M. Raghunath, Hydrology: Principles, Analysis and Design, 2nd edition, New Age International Publishers.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Mathematics**

1. Subject Code: **MAN-006** Course Title: **Probability and Statistics**

2. Contact Hours: **L: 3** **T: 1** **P : 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: BSC**

8. Pre-requisite**: Nil**

9. Objective: To impart techniques of Probability and Statistics.

10. Details of Course:

S.No.	Contents	Contact Hours
1	Concept of probability, random variable and distribution function: discrete and continuous, moments and moment generating functions.	**9**
2	Special distributions (discrete): Binomial, Poisson, Negative binomial, Geometric. (continuous): Uniform, Exponential, Gamma, Beta, Normal, Lognormal.	**9**
4	Bivariate random variables: joint, marginal, conditional distribution. Statistical independence, product moment.	**3**
5	Random sample, law of large numbers, central limit theorem, correlation, regression.	**7**
6	Estimation: maximum likelihood estimation, unbiasedness and efficiency, interval estimation for normal population with normal, t, χ^2 distribution.	**7**
7	Testing of Hypothesis: Simple and composite hypothesis, Type I and type II errors. Power of test. Some tests for normal population parameters based on normal, t, χ^2 distribution.	**7**
	TOTAL	**42**

11. Suggested Books:

S.No.	Title/Authors/Publishers	Year of Publication
1.	Rohatgi, V K. and Saleh , A. K. Md. Ehsanes, "An Introduction to Probability and Statistics", (John Wiley and Sons) , (2^{nd} edition)	2000
2.	Hogg, R. V. and Craig, A., "Probability and Statistical Inference", (Pearson Education), (6^{th} Edition)	2006
3.	Johnson, R. A., Miller, I. and Freund, J. E., "Miller & Freund's probability and statistics for engineers", (Prentice Hall PTR), (8^{th} edition)	2011
4.	Hines, W. W., Montgomery, D. C., Goldsman, D. M. and Borror, C. M.,	2003

	"Probability and Statistics in Engineering", (John Wiley & sons), (4^{th} Edition)	
5.	Papoulis, A. and Pillai, S. U., "Probability, Random Variables and Stochastic Processes", (Tata McGraw-Hill), (4^{th} edition)	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Physics**

1. Subject Code: **PHN-001** Course Title: **Physics Department**
2. Contact Hours: **L: 3** **T : 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**
4. Relative Weightage**:** **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: BSC**
8. Pre-requisite**: None**
9. Objective: **To familiarize students with the basic principles of mechanics**
10. Details of Course:

S.No.	Contents	Contact Hours
1	**STATICS OF PARTICLES.** Vectorial representation of forces and moments- Vector Operation-Concepts of Particles and Rigid bodies – Composition of concurrent forces in plane free body Diagram – Equilibrium of Rigid bodies in Two and three dimensions-Moment of a force about a point and about an axis-Couple moment-Reduction of a force system to a force and a couple	**8**
2	**PROPERTIES OF SURFACES, MOMENTS AND PRODUCTS OF INERTIA** Definition Moment of Inertia for areas-Parallel axis theorem –Perpendicular axis theorem-Moment of inertia for composite area-product of inertia form an area-mass moment of inertia	**6**
4	**FRICTION** Laws of coulomb friction- Coefficient of Friction-Dry Friction-sliding Friction-Ladder friction-Belt friction – Rolling Resistance.	**4**
5	**KINEMATICS OF PARTICLES** Principle of virtual work for a particle and rigid body-condition for equilibrium for a conservative system, stability-particle dynamics in rectangular coordinate, cylindrical coordinate and in terms of path variables-General motion of system of particles-	**8**
6	**WORK ENERGY METHODS, IMPULSE AND MOMENTUM** Work Energy Method-Conservation of Energy-Impulse and Momentum Relation-Impulsive Force-Impact force-Conservation of momentum – Moment of Momentum Equation.	**8**
7	**RIGID BODY MOTION;** Translation and rotation of rigid bodies- Derivative of a vector fixed in moving reference-General relationship between time derivative of a vector for different references-Moment of momentum equation-kinetic energy of rigid body-work and energy relations-Euler's equation of motion-Three dimensional motion about a fixed point	**8**
	TOTAL	**42**

List of experiments:

1. Study of magnetic field of a pair of coils in Helmholtz arrangement
2. Determination of e/m
3. Determination of first excitation potential of a gas by Frank-Hertz experiment
4. Determination of Stefan's constant
5. Determination of Planck's constant by radiation
6. To study and verify Malus' law
7. Study of Polarization of light using quarter wave plate
8. Determination of Brewster's angle at glass-air interface
9. Determination of with of a slit by single-slit diffraction pattern
10. Four probe method of finding resistivity of semiconductor
11. Quinck's Method for determining mass susceptibility
12. Wavelength of Na light by Newton's ring method

11. Suggested Books:

S.No.	Title/Authors/Publishers	Year of Publication
1.	Shames I.H. and Rao G.K., "Engineering Mechanics-Statics and Dynamics" ,4 Edition, Pearson Education	2006
2.	Beer F.P and Johnson E.R., "Vector Mechanics for Engineers- Statics and Dynamics",9 Edition, Tata McGraw-Hill Publishing Company	2010
3.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Statics" 3rd Edition, Cengage Learing	2010
4.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Dynamics"3rd Edition Cengage Learing	2010
5.	Hibberler R.C and Gupta A., Engineering Mechanics,", 12th Edition, Pearson Education	2012
6.	Meriam J.L. and Kraige L.G., "Engineering Mechanics: Statics", 6th Edition, John Willey and Son,s	2012
7.	Meriam J.L., and Kraige L.G., "Engineering Mechanics: Dynamics", 6th Edition , John Willey and Son's	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE **:** **Department of Physics**

1. Subject Code**:** **PHN-008** Course Title**: Electromagnetic Theory**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**

4. Relative Weightage**:** **CWS: 25** **PRS: 0** **MTE : 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: BSC**

8. Pre-requisite**: None**

9. Objective: To impart basic concepts of electromagnetism and their applications in engineering.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Vector A lgebra:** Cartesian, Cylindrical and Spherical coordinate Systems, Constant coordinate surfaces, Del operator, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stokes theorem, Gradient, Divergence, Curl and Laplacian in the three coordinate Systems, Laplacian of a scalar, Scalar & Vector Fields, Classification of Vector fields.	**9**
2	**Electrostatics:** Coulomb's law, electric field intensity due to continuous charge distribution, Gauss's law & its applications, electric potential, the line integral, electric dipole and flux lines, energy density in an electrostatic field, electrostatic discharge. Current and current density, metallic conductors, conductor properties and boundary conditions, polarization in dielectrics, nature of Dielectric materials and related boundary conditions, capacitance.Electrostatic boundary-value problems, Laplace's and Poisson's equations, Uniqueness theorem, General procedure for solving Laplace's and Poisson's equation.	**11**
3	**Magnetostatics:** Biot-Savart's law, Ampere's circuital law, Applications of Ampere's law, Magnetic flux and magnetic flux density, Scalar and vector magnetic potentials.Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Inductors, inductances, Magnetic energy, Magnetic circuits, Potential energy and force on magnetic materials, magnetic levitation.	**11**

4	**Time va rying electric and m agnetic f ields an d electromagnetic waves:** Faraday's law, transformer, EMF, DC motors, displacement current, Maxwell's equations for time varying fields, electromagnetic wave equation in free space, plane waves in free space, polarization, Poynting vector and power associated with electromagnetic waves, plane waves in lossless, homogeneous, and isotropic dielectric, reflection and transmission of plane waves at dielectric interface, normal and oblique incidence, plane waves in good conductors, skin depth. Microwaves and their applications in telecommunication, radar, and heating.	**11**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	William H Hayt, Jr., and John A. "Engineering Electromagnetics", Buck, Tata McGraw Hill Publishing Company Ltd, New Delhi, 7th Ed.	**2005**
2.	Matthew N.O. Sadiku,"Elements of Engineering Electromagnetics" , Oxford University Press, 3rd Ed.	**2003**
3.	Nannapaneni Narayan Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India, New Delhi, 4th Ed.	**2000**
4.	D.J. Griffiths, "Introduction to Electrodynamics", Prentice Hall, 3rd Ed.	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Mechanical & Industrial Engineering**

1. Subject Code: **MIN-106** Course Title: **Engineering Thermodynamics**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage: **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits: **4** 6. Semester: **Both** 7. Subject Area: **DCC/ESC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize the students with basic concepts of macroscopic thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Introduction to thermodynamic system, surrounding, state, process, properties, equilibrium, heat and work, Zeroth Law of Thermodynamics	**3**
2.	**Properties of Pure Simple Compressible Substance:** PvT surface, Pv, Tv, TP diagrams. Equation of state for ideal and real gases. Virial equation of state, van der Waal equation, use of steam tables and Mollier diagram	**6**
3.	**First Law of Thermodynamics:** First law application to non-flow processes such as isochoric, isobaric, isothermal, adiabatic and polytropic processes. Steady flow energy equation, flow work. Application to various practical systems viz. nozzles, diffuser, turbines, heat exchangers etc. Application of energy equation to transient flow problems.	**7**
4.	**Second Law of Thermodynamics:** Second law, reversible and irreversible processes, Clausius and Kelvin Planck statements, Carnot cycle, corollaries of second law: thermodynamic temperature scale, Clausius inequality, entropy as a property, principle of increase of entropy. Calculation of entropy change.	**6**
5.	**Entropy and Exergy:** Entropy and its generation, entropy balance for closed system and for control volume, basic concepts of exergy and irreversibility, exergy for closed system and control volume, exegetic efficiency.	**5**

6.	**Gas-Vapour M ixtures and A ir-conditioning:** Properties of gas-vapour mixtures, adiabatic-saturation and wet-bulb temperatures, psychrometric chart, human comfort and air conditioning, various air conditioning processes.	**4**
7.	**Gas and Vapour Power Cycles:** Otto, Diesel, Dual, Stirling, Joule-Brayton cycle. Thermal efficiency and mean effective pressure, Rankine cycle.	**5**
8.	**Refrigeration C ycles:** reverse Carnot cycle, vapour compression refrigeration cycle.	**4**
	TOTAL	**42**

List of Experiments:

1. Study of P-V-T surface of H_2O and CO_2.
2. Determine P-T relationship for steam and verify Clausius Clapeyron equation.
3. Determine the calorific value of coal using Bomb calorimeter.
4. Analysing exhaust gases using Orsat apparatus.
5. Determine Relative Humidity and Specific Humidity of air using Sling Psychrometer and Psychrometric Chart.
6. Determine COP of a vapour compression refrigeration unit.
7. Analysing different processes on an air conditioning unit.

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Borgnakke, C. and Sonntag, R.E., " Fundamentals of Thermodynamics," Wiley India	2011
2.	Cengel, Y.A. and Boles, M.A., "Thermodynamics an Engineering Approach", Tata McGraw-Hill	2008
3.	Moran, M.J. and Shapiro, H.M., "Fundamentals of Engineering Thermodynamics", 4th Ed., John Wiley	2010
4.	Russel, L.D., Adebiyi, G. A.," Engineering Thermodynamics", Oxford University Press	2007
5.	Arora, C.P., "Thermodynamics", Tata-McGraw Hill	2001
6.	Nag, P.K., "Engineering Thermodynamics", Tata-McGraw Hill	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **DEPARTMENT OF CIVIL ENGINEERING**

1. Subject code: **CEN-105** Course Title: **Introduction to Environmental Studies**
2. Contact Hours: **L: 3 T: 0 P: 0**
3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0
4. Relative Weightage: **CWS:** 15 **PRS:** 0 **MTE:** 35 **ETE:** 50 **PRE:** 00
5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **GSC**
8. Pre-requisite: **Nil**
9. Objective: To introduce fundamentals of environmental pollution and its control.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview: Environment and Natural Processes; Development (Resource Utilization & Waste Generation); Environmental issues; Concept of Sustainable Development; Issues affecting future development (population, urbanization, health, water scarcity, energy, climate change, toxic chemicals, finite resources etc.); Environmental units	6
2.	Air –Water interaction: (Liquid phase-gas phase equilibrium) Henry's Law Constant with units, Dimensionless Henry's Law Constant	3
3.	Water –Soil Interaction: Carbonate System (Alkalinity and buffering capacity); Major ions in water; Natural Organic Matter (NOMs); Water quality parameters; Physical processes (Mass Balance): Spatio-temporal variation in quality of river water, lake water, ground water; Water quality standards	9
4.	Wetlands, water treatment and wastewater treatment .	6
5.	Air resources: Atmosphere; Air pollutants; Emissions and control of air pollutants; Atmospheric meteorology and dispersion; Transport of air (global, regional, local); Air/ atmospheric stability; Plume shape; Gaussian modeling; Air quality standards	9
6.	Land pollution and solid waste management	3
7.	Ecosystem: Structure and function; Energy flow in ecosystem; Material flow in ecosystem; Biodiversity and ecosystem health; Bio-amplification and bio-magnification	3
8.	Hazardous Waste: Definition; Classification; Storage and management; Site remediation; Environmental Risk: assessment, and management	3
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davis M. L. and Cornwell D. A., "Introduction to Environmental Engineering", McGraw Hill, New York 4/e	2008
2.	Masters G. M., Joseph K. and Nagendran R. "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi. 2/e	2007
3.	Peavy H. S., Rowe D.R. and Tchobanoglous G., "Environmental Engineering", McGraw Hill, New York	1986
4.	Mines R. O. and Lackey L. W. ""Introduction to Environmental Engineering", Prentice Hall, New Yark	2009
5.	Miheicic J. R. and Zimmerman J. B. " Environmental Engineering: Fundamentals, Sustainability, Design" John Wiley and Sons, Inc.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001A** Course Title: **Communication Skills (Basic)**

2. Contact Hours: **L: 1** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 2 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective:
The course intends to build the required communication skills of the students having limited communicative abilities, so that they may communicate effectively in real-life situations

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Understanding the Basics of Communication Skills: Listening, Speaking, Reading & Writing, Scope and Importance	**01**
2.	Grammar & Composition: Time and Tense, Agreement, Active-Passive, Narration, Use of Determiners, Prepositions & Phrasal Verbs	**05**
3.	Vocabulary Building & Writing: Word-formation, Synonyms, Antonyms, Homonyms, One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words	**02**
4.	Introduction to Sounds (Vowels & Consonants) Organs of Speech, Place and Manner of Articulation, Stress & Intonation, Listening Comprehension (Practical Sessions in Language Laboratory)	**02**

5.	Speaking, Countering Stage-fright and Related Barriers to Communication.	**02**
6.	Reading and Comprehension: Two lessons to be identified by the department.	**02**
	Total	**14**

List of Practicals:

1. Ice-breaking Exercises
2. Assignments on Time and Tense, Agreement, Active-Passive
3. Laboratory Session on Narration, Use of Determiners, Prepositions & Phrasal Verbs, Revisionary Exercises & Quiz
4. Laboratory Session on Synonyms, Antonyms, Homonyms
5. Assignments and Practice Sheets on One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words
6. Laboratory Session on Practice of sounds, Intonation and Stress, Listening Comprehension
7. Individual presentation, debates, Extempore & Turncoats
8. Exercises in Composition and Comprehension

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Murphy, Raymond. *Intermediate English Grammar*, New Delhi, Cambridge University Press.	**2009**
2.	Quirk, Randolph & Sidney Greenbaum. *A University Grammar of English*, New Delhi, Pearson.	**2009**
3.	McCarthy, Michael & Felicity O' Dell. *English Vocabulary in Use*, New Delhi, Cambridge University Press	**2010**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Birchfield, Susan M. *Fowler's Modern English Usage*, New Delhi, OUP.	**2004**
6.	Llyod, Susan M. *Roget's Thesaurus of English Words and Phrases*. New Delhi: Penguin.	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001B** Course Title: **Communication Skills (Advanced)**

2. Contact Hours: **L: 1** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 2 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective: The course intends to train the learners in using both verbal and non-verbal communication effectively.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Advanced Communication Skills: Scope, Relevance, & Importance	01
2.	Soft Skills: Interpersonal Communication; Verbal & Non-verbal, Persuasion, Negotiation, Neuro-Linguistic Programming	03
3.	Communication and Media (Social and Popular), The Social and Political Context of Communication, Recent Developments and Current Debates in Media	04
4.	Cross-cultural and Global Issues in Communication: Race, Ethnicity, Gender & Diaspora	03
5.	Rhetoric and Public Communication, Audience Awareness, Emotionality	03
	Total	14

List of Experiments:

1. Discussion on the Process of Communication in Personal and Professional Life
2. Group Discussion, Case Studies and Role-Play
3. Assignments on E-mail Etiquette, Social Networking, Blog Writing, Discussions on Current Issues
4. Non-Verbal Communication in Cross-Cultural Situations, Case Studies, Group Discussions and Readings on Topics Related to Race, Ethnicity , Gender and Diaspora
5. Individual Presentations (Audience Awareness, Delivery and Content of Presentation)

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Rentz, Kathryn, Marie E. Flatley & Paula Lentz. *Lesikar's Business Communication CONNECTING IH A DIGITAL WORLD*, McGraw-Hill, Irwin	**2012**
2.	Bovee, Courtland L & John V. Thill. *Business Communication Today*. New Delhi, Pearson Education	**2010**
3.	McMurrey, David A. & Joanne Buckley. *Handbook for Technical Writing*, New Delhi, Cengage Learning.	**2009**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Allan & Barbara Pease. *The Definitive Book of Body Language*, New York, Bantam	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities and Social Sciences**

1. Subject Code: **HSN-002** Course Title: **Ethics and Self-awareness**

2. Contact Hours: **L: 01** **T: 0 1** **P: 0**

3. Examination Duration (Hrs.): **Theory 2** **Practical 0**

4.Relative Weight**: CWS:25 PRS:0 MTE:25 ETE:50 PRE:0**

5. Credit **02** 6. Semester**: Autumn** 7. Subject Area**: HSSC**

8. Pre-requisite**: NIL**

9. Objective: To introduce the concepts pertaining to ethical and moral reasoning and action and to develop self - awareness.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction**: Definition of Ethics; Approaches to Ethics: Psychological, Philosophical, Social.	**1**
2	**Psycho-social theories of moral development**: View of Kohlberg; Morality and Ideology, Culture and Morality, Morality in everyday context.	**3**
3	**Ethical Concerns**: Work Ethics and Work Values, Business Ethics, Human values in organizations.	**3**
4	**Self-Awareness**: Self Concept: Johari Window, Self and Culture, Self Knowledge, Self-Esteem; Perceived Self-control, Self-serving bias, Self-presentation, Self-growth: Transactional Analysis and Life Scripts.	**4**
5.	**Self Development**: Character strengths and virtues, Emotional intelligence, Social intelligence, Positive cognitive states and processes (Self-efficacy, Empathy, Gratitude, Compassion, and Forgiveness).	**3**
	Total	**14**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication
1.	Hall, Calvin S., Lindzey, Dardner., & Cambell, John B.,"Theories of Personality",Hamilton Printing Company.	1998
2.	Car Alan, "Positive Psychology: The Science of Happiness and Human Strengths", Brunner-Routledge.	2004
3.	Leary M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press.	2004
4.	Louis P. P., "The Moral Life: An Introductory Reader in Ethics and Literature", Oxford University Press.	2007
5.	Corey, G., Schneider Corey, M., & Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole.	2011
6.	Snyder, C.R., Lopez, Shane, J., & Pedrotti, J.T., "Positive Psychology" Sage, 2nd edition.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics Department**

1. Subject Code: **MAN-001** Course Title: **Mathematics I**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weightage**:** **CWS** 25 **PRS** 00 25 50 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: BSC**

8. Pre-requisite**:** **None**

9. Objective: **To provide essential knowledge of basic tools of Differential Calculus, Integral Calculus , Vector Calculus and Matrix Algebra for degree students.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Matrix Algebra:** Elementary operations and their use in getting the Rank, Inverse of a matrix and solution of linear simultaneous equations. Orthogonal, Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, Normal & Unitary matrices and their elementary properties. Eigen-values and Eigenvectors of a matrix, Cayley-Hamilton theorem, Diagonalization of a matrix.	**8**
2.	**Differential Calculus:** Limit, Continuity and differentiability of functions of two variables, Euler's theorem for homogeneous equations, Tangent plane and normal. Change of variables, chain rule, Jacobians, Taylor's Theorem for two variables, Error approximations. Extrema of functions of two or more variables, Lagrange's method of undetermined multipliers	**12**
3.	**Integral Calculus:** Review of curve tracing and quadric surfaces, Double and Triple integrals, Change of order of integration. Change of variables. Gamma and Beta functions. Dirichlet's integral. Applications of Multiple integrals such as surface area, volumes, centre of gravity and moment of inertia..	**12**
4.	**Vector Calculus:** Differentiation of vectors, gradient, divergence, curl and their physical meaning. Identities involving gradient, divergence and curl. Line and surface integrals. Green's, Gauss and Stroke's theorem and their applications.	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	E. Kreyszig, Advanced Engineering Mathematics, 9th edition, John Wiley and Sons, Inc., U.K.	2011
2.	R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House.	2005
3.	M.D. Weir, J. Hass, F.R. Giordano, Thomas' Calculus, 11th Edition, Pearson Education.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Physics**

1. Subject Code: **PHN-001** Course Title: **Mechanics**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**
4. Relative Weightage**:** **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: BSC**
8. Pre-requisite**: None**
9. Objective: **To familiarize students with the basic principles of mechanics**
10. Details of Course:

S.No.	Contents	Contact Hours
1	**STATICS OF PARTICLES.** Vectorial representation of forces and moments- Vector Operation-Concepts of Particles and Rigid bodies – Composition of concurrent forces in plane free body Diagram – Equilibrium of Rigid bodies in Two and three dimensions-Moment of a force about a point and about an axis-Couple moment-Reduction of a force system to a force and a couple	**8**
2	**PROPERTIES OF SURFACES, MOMENTS AND PRODUCTS OF INERTIA** Definition Moment of Inertia for areas-Parallel axis theorem –Perpendicular axis theorem-Moment of inertia for composite area-product of inertia form an area-mass moment of inertia	**6**
4	**FRICTION** Laws of coulomb friction- Coefficient of Friction-Dry Friction-sliding Friction-Ladder friction-Belt friction – Rolling Resistance.	**4**
5	**KINEMATICS OF PARTICLES** Principle of virtual work for a particle and rigid body-condition for equilibrium for a conservative system, stability-particle dynamics in rectangular coordinate, cylindrical coordinate and in terms of path variables-General motion of system of particles-	**8**
6	**WORK ENERGY METHODS, IMPULSE AND MOMENTUM** Work Energy Method-Conservation of Energy-Impulse and Momentum Relation-Impulsive Force-Impact force-Conservation of momentum – Moment of Momentum Equation.	**8**
7	**RIGID BODY MOTION;** Translation and rotation of rigid bodies- Derivative of a vector fixed in moving reference-General relationship between time derivative of a vector for different references-Moment of momentum equation-kinetic energy of rigid body-work and energy relations-Euler's equation of motion-Three dimensional motion about a fixed point	**8**
	TOTAL	**42**

List of experiments:

1. Study of magnetic field of a pair of coils in Helmholtz arrangement
2. Determination of e/m
3. Determination of first excitation potential of a gas by Frank-Hertz experiment
4. Determination of Stefan's constant
5. Determination of Planck's constant by radiation
6. To study and verify Malus' law
7. Study of Polarization of light using quarter wave plate
8. Determination of Brewster's angle at glass-air interface
9. Determination of with of a slit by single-slit diffraction pattern
10. Four probe method of finding resistivity of semiconductor
11. Quinck's Method for determining mass susceptibility
12. Wavelength of Na light by Newton's ring method

11. Suggested Books:

S.No.	Title/Authors/Publishers	Year of Publication
1.	Shames I.H. and Rao G.K., "Engineering Mechanics-Statics and Dynamics" ,4 Edition, Pearson Education	2006
2.	Beer F.P and Johnson E.R., "Vector Mechanics for Engineers- Statics and Dynamics",9 Edition, Tata McGraw-Hill Publishing Company	2010
3.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Statics" 3rd Edition, Cengage Learing	2010
4.	Pytel A. and Kiusalaas J., " Engineering Mechanics: Dynamics"3rd Edition Cengage Learing	2010
5.	Hibberler R.C and Gupta A., Engineering Mechanics,", 12th Edition, Pearson Education	2012
6.	Meriam J.L. and Kraige L.G., "Engineering Mechanics: Statics", 6th Edition, John Willey and Son,s	2012
7.	Meriam J.L., and Kraige L.G., "Engineering Mechanics: Dynamics", 6th Edition , John Willey and Son's	2012