ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

No. Acd./3161 /IAPC-78 Dated: February 05, 2020

Head, Department of Earth Sciences
(through e-mail)

The IAPC in its 78th meeting held on 31.12.2019 vide **Item No. 78.2.4** considered the proposal of Department of Earth Sciences to introduce the following new Pre-Ph.D. courses:

1. **ESN-901: Advanced Magnetotelluric Methods**
2. **ESN-902: Sequence Stratigraphy**
3. **ESN-903: Principles of Numerical Geophysical Modeling**
4. **ESN-904: Experimental and Analytical Techniques applied in Geosciences**
5. **ESN-905: Reservoir Formation Evaluation**
6. **ESN-906: Rock Mechanics**
7. **ESN-907: Gravity and Magnetic Surveying**
8. **ESN-908: Hydrogeophysics**
9. **ESN-909: Modeling of Strong Motion Data**

The IAPC accepted the proposal with minor modifications. Duly modified syllabi is attached as **Appendix-A**.

Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. All Heads of Departments/ Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: EARTH SCIENCES

1. **Subject Code:** ESN-901 **Course Title:** ADVANCED MAGNETOTELLURIC METHODS
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs):** **Theory:** 3 **Practical:** 0
4. **Relative Weight age:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Basics Knowledge of Electromagnetic prospecting techniques
9. **Objective of Course:** To impart the knowledge of Advance techniques in Magnetotelluric data acquisition, processing and inversion.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Frequency range in primary natural electromagnetic field, generation mechanism of natural electromagnetic source field, their characteristics in time and space.	**4**
2.	General physical principles of the magnetotelluric (MT) soundings methods. Schematic models of primary magnetotelluric source field, linear algebraic relationships between the components of magnetotelluric field, magnetotelluric impedance, admittance and magnetic induction arrows.	**6**
3.	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.	**4**
4.	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**
5.	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.	**4**
6.	Separation of the local and regional MT effects, various methods for impedance decomposition. 2D and 3D modeling and inversion of MT data synthetic examples and case studies.	**8**
7.	Mini-project on MT data processing and multi-dimensional inversion using AP3DMT, Winglink	**10**
	Total	**42**

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, Cambridge University Press	**2012**
2	Foundations of Geophysical Electromagnetic Theory and Methods 2nd Edition, By Michael Zhdanov, Elsevier	**2017**
3.	*Models and methods of Magnetotelluric* By Mark N. Berdichevsky and Vladimir I. Dmitriev, Springer	**2008**
4.	*Practical Magnetotellurics* By Fiona Simpson and Karsten Bahr	**2005**

5.	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**
6.	*The Magnetotelluric sounding method* By Kaufman, A. A. and Keller, G. V. Elsevier Amsterdam	**1981**
7.	Fiona Simpson and Karsten Bahr, Practical Magnetotellurics, Cambridge University Press	**2005**
8.	Mark N Berdichevsky and Vladimir I Dmitriev , "Models and methods of Magnetotelluric" Springer-Verlag Berlin	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: EARTH SCIENCES

1. **Subject Code:** ESN-902 **Course Title:** SEQUENCE STRATIGRAPHY
2. **Contact hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination duration (hrs):** **Theory:** 3 **Practical:** 0
4. **Relative weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** NIL
9. **Objective:** To impart knowledge of sequence stratigraphy and its application in characterizing facies models of different sedimentary depositional environments.

10. Details of course:

Sl. No.	Contents	Contact hours
1.	Sequence stratigraphy – basic concepts and principles; standard methodology	04
2.	Cyclicity and correlation in stratigraphic successions	04
3.	Concepts of Cyclostratigraphy – tectonic and orbital forcings	04
4.	Base level and accommodation; Eustasy and sea level changes – concept and controls; stratal stacking patterns	04
5.	Concepts of Depositional System, Facies and Facies Models	04
6.	Sequence elements and their implications; concept of parasequences, systems tracts, boundaries	04
7.	Hierarchy of sequence and sequence boundaries	02
8.	Types of stratigraphic sequences - depositional sequence, genetic stratigraphic sequence, transgressive-regressive (T-R) sequence	04
9.	Sequence stratigraphic model of common sedimentary environments – shallow marine, deep marine and continental	08
10.	Case studies on sequence stratigraphic architecture from recent and ancient depositional systems	04
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors/Publishers	Year
1.	Catuneanu, O.: Principles of Sequence Stratigraphy. Elsevier.	2006
2.	Montenari, M.: Advances in sequence stratigraphy, 2nd vol., 1st ed. Elsevier	2017
3.	Nichols, G.: Sedimentology and stratigraphy, 2nd Ed. Wiley-Blacwell	2009
4.	Boggs, Sam (Jr.): Principles of Sedimentology and Stratigraphy, 4th Ed. Pearson/Prentice Hall.	2012
5.	Emery, D.: Sequence stratigraphy. 1st ed. Wiley Blackwell.	2013
6.	Miall, A. D.: The Geology of stratigraphic sequences, 2nd Ed. Springer.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: EARTH SCIENCES

1. **Subject Code:** ESN-903 **Course Title:** Principles of Numerical Geophysical Modeling
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage: CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** None
9. **Objective:** To teach basics of programming and computational techniques/methods essential for numerical modeling of geological processes.

10. Details of Course:

S. No	Contents	Contact Hours
1.	Introduction to programming: Data types, Initialization, expressing common mathematical expressions in MATLAB, loops, if statements, matrix operations, function handling.	**8**
2.	Interpolations schemes: polynomial interpolations, Lagrange interpolations, spline interpolation, regression.	**4**
3.	Applications of Taylor and Fourier Series: Newton's methods for finding the root.	**4**
4.	Numerical Integration and Differentiation: Midpoint rule, Trapezoidal rule, Simpson's Rule, forward center and backward derivatives. Numerical Discretization: Fredholm's equation and its application.	**6**
5.	Numerical solutions to ordinary differential equations: direction fields, Euler's method, Runge-Kutta Method.	**4**
6.	Iterative solutions to Linear equations: Jacobi method, Gauss-Seidel method. Basics of probability.	**4**
7.	Finite difference Method: explicit and implicit methods, Crank-Nicolson method, Applications to 1D and 2D heat equation and acoustic wave equation, Von Neuman stability analysis, CFL condition, handling boundary conditions.	**8**
8.	Method of Weighted Residual: Collocation method, Least Square method, Galerkin Method, Symmetric Variational Formulation, basics of finite element method.	**4**
	Total	**42**

11. Suggested Books:

S. No	Name of Authors/ Books/ Publishers	Year of Publication
1.	Linear Algebra and its Application, Gilbert Strang; Cengage Publications	**2005**
2.	Introduction to Numerical Geodynamic Modelling, Taras Gerya; Cambridge University Press	**2011**
3.	Parameter Estimation and Inverse Problem, R. C. Aster, B. Brochers, and, C. H. Thurber; Academics Press	**2005**
4.	Computation Seismology, Heiner Igel; Oxford University Press	**2017**
5.	Numerical Methods for Partial Differential Equations, G. Evans, J. Blackledge, and, P. Yardley; Springer	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Earth Sciences

1. **Subject Code:** ESN-904 **Course Title:** Experimental and Analytical Techniques applied in Geosciences
2. **Contact Hours:** **L:** 3 **T:** 0 **P:** 2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 2
4. **Relative Weightage:** **CWS:** 10-25 **PRS:** 25 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide fundamental understanding of the principles, usage and application of a range of Experimental and Analytical Techniques applied in Geosciences.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to various kind of analytical, imaging and experimental techniques in geosciences	2
2	Principles of various kind analytical equipment, techniques, and sample preparations and measurement protocols e.g. XRD, XRF, FTIR, IC, EPMA etc	6
3	**Microbeam analytical techniques I**: Analysis of chemical and isotopic compositions of Earth and Planetary materials, by spectrum methods using traditional techniques of electron probe micro-analyzer (EPMA), field emission EPMA, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy and X-ray microprobe, and by mass spectrometry using modern techniques of laser-ablation inductively-coupled plasma quadrupole/multi-collector mass spectrometry (LA-Q/MC-ICPMS), secondary ion mass spectrometry (SIMS), NanoSIMS (SIMS at spatial resolution of nanometers), and atom probe tomography (APT).	8
4	**Microbeam analytical techniques II**: Electron microscopy, using the scanning electron microscope (SEM), field emission SEM and transmission electron microscope (TEM) to investigate micro and nano structures of a wide range of geological specimens.	4
5	**Mass Spectrometry:** Principals of mass spectrometry and various kind of mass spectrometer and their application. Sample preparations protocols for various kind of mass spectrometer e.g. IRMS, ICP-MS, ICP-OES, TIMS etc	10
6	**Experimental techniques I:** Synthesis methods at high pressure and temperature	4
7	**Experimental techniques II**: In-situ methods for measuring physical properties	4
8	Application of Mass Spectrometers and others equipment in Hydrological, Petrological, Plate Tectonics and planetary sciences	4
	Total	42

List of Practicals :

Sample preparation and instrumentation: EPMA
Sample preparation and instrumentation: SEM
Sample Preparation and Instrumentation ICP-MS analysis (bulk and trace elements)
Sample preparation and isotopic data analysis on IRMS and interpretation of data
Instrumentation and Interpretation of IC, XRD and XRF data.
Experiments at High Temperature and High pressure

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Introduction to Mineral Sciences, A. Putnis. Cambridge University Press, p. 128	1992
2.	Microprobe techniques in the earth sciences, edited by Philip J. Potts, John F. W. Bowles, Stephen J. B. Reed and Mark R. Cave. 1st ed. London; New York : Chapman & Hall. P. 419	1995
3.	Scanning electron microscopy and X-ray microanalysis: a text for biologists, materials scientists, and geologists, Joseph I. Goldstein ... [et al.] New York: Plenum Press, c1981. xiii, 673 p. QH212.S3 S29	1981
4.	Transmission electron microscopy of minerals and rocks, Alex C. McLaren. Cambridge; New York : Cambridge University Press, p. 387	1991
5.	X-Ray powder diffractometry, R. Jenkins & R.L. Snyder. Wiley & Sons; New York. P. 403	1996
6.	Introduction to Mass Spectrometry: Instrumentation, Applications and Strategies for Data Interpretation, J. Throck Watson, O. David Sparkman. John Wiley & Sons, Ltd.,	2007
7.	Mass Spectrometry : A Text Book, **Gross**, Jürgen H. , Springer , p. 324	2017

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: **EARTH SCIENCES**

1. **Subject Code:** ESN-905 **Course Title:** Reservoir Formation Evaluation
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Basic knowledge of Well-Logging
9. **Objective:** The main aim of the course is to give understanding of the procedures of acquiring, processing and interpreting formation evaluation data in reservoir/non-reservoir setting.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction to Conventional Log Types:** Triple-Combo, Quad-Combo sets	4
2.	**Consistent and Filed Units of Logs and other related calculations:** Understanding of conventional plotting units and its interchangeability with respect to the change in lithology and formation	4
3.	**Extreme Condition Adaptation of Conventional Logs:** Miniaturization and modernization of Tools to adapt to need of high temperature and pressure conditions and other challenges	4
4.	**Advancements in LWD and MWD Logs:** Evolution of Logging While Drilling (LWD) and Measurement While Drilling (MWD) the recent trends and limitations	4
5.	**New Innovations in Acquisition, Processing of Well Log Data:** Routine Core Analysis, Special Core Analysis, strength tests, Gas Research Institute (GRI), conventional versus unconventional, steady state and pseudo-steady state permeability, Dipole Shear Sonic Imager (DSSI) Logs, Sonic Scanner, RT Scanner, Geochemical Logs, Dielectric Logs	8
7.	**Conductivity and Acoustic Based Imaging Logs:** Impact of mineralogy, volume of shale (Vshale) and salinity on grain density, Identification of thin laminations and impact on Net-to-Gross evaluation, Identification of fracture networks and systems	6
8.	**Interpretation Techniques and Formation specific Interpretation Workflows :** Pickett plots, Hingle plots, Buckles Plot**,** Luffel Plot, Laminated shaly-sand, Carbonate Formations, Unconventional Resources (Shale play, CBM, Gas Hydrates)	8
9.	**Coding based processing of data and its interpretation**: Preparation of project report and presentation on use of any of the advance logs/case study	4
	Total	**42**

11. Suggested Books:

S. No	Name of Authors/ Books/ Publishers	Year of Pub.
1.	Petrophysics: Theory and Practice of Measuring Author: Djebbar Tiab and Erie C Donaldson Publisher: Gulf Professional Publishing	2018
2.	Petrophysics: Fundamental of Petrophysics of Oil and Gas Reservoirs Authors: Leonid Buryakovsky, George V. Chilingar, Herman H. Rieke, Sanghee	2012

	Shin Publisher: Scrivener (Wiley) Publishing LLC	
3.	Petroleum Reservoir Rock and Fluid Properties Author: Abhijit Y Dandekar Publisher: CRC Press	2013
4.	Well Logging and Formation Evaluation Author: Toby Darling Publisher: Gulf Publishing	2005
5.	Introduction to geophysical formation evaluation Author: James K. Hallenburg Publishers: Lewis publishers	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Earth Sciences

1. **Subject Code:** ESN-906 **Course Title:** Rock Mechanics
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the fundamental concepts and principles of rock mechanics for application in geological problems

10. Details of Course:

S. No.	Contents	Contact Hours
1	Natural rock environments, Rock as an engineering material, aspects of weathering and impacts on planning of engineering projects	2
2	Concept of stress and strain, In-situ stresses in rocks and methods of stress measurement and interpretations	6
3	Rock and rock mass properties, Engineering properties of rock, Strength and failure criteria of rocks, Laboratory testing for the measurement of strength and deformation behaviour of intact rocks and their interpretation to determine the strength and deformation parameters	8
4	The influence of geological factors and weathering on rocks and rock masses, Effect of clay mineralisation on rock strength.	6
5	Rock mass classification- Rock Mass Rating, Slope Mass Rating, Q-System, Geological Strength Index, Applications of rock mass classification systems, Links between the classification systems and rock properties	8
6	Characterization of rock discontinuities and their fundamental properties, Discontinuity roughness coefficient, Discontinuity wall compressive strength, Residual friction angle of the discontinuity	6
7	Effect of Stress on Reservoir Rock Properties, Compaction or compressibility behaviour of petroleum reservoirs	6
	Total	**42**

11. Suggested Books:

Sl.No	Name of Books / Authors	Year
1	Introduction to Rock Mechanics, Goodman R E John Wiley & Sons, New York	1989
2	Engineering Rock Mechanics: An Introduction to the Principles, Hudson J A and Harrison J P, Elsevier.	1997
3	Rock mass classification: A practical approach in Civil Engineering, Singh B and Goel R K, Elsevier.	2011
4	*Practical Rock Mechanics*, Hencher S, CRC Press	2015
5	Engineering Properties of Rocks, Zhang L, Elsevier	2017
6	Petrophysics Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties, Tiab D and Donaldson E C, Elsevier	2004
7	Reservoir Geomechanics, Zoback M, Cambridge University Press	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Earth Sciences

1. **Subject Code:** ESN-907 **Course Title:** Gravity and Magnetic surveying
2. **Contact Hours:** **L:** 3 **T:** 0 **P:** 2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 10-25 **PRS:** 25 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce details of Gravity and Magnetic surveying

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to Geophysical Survey design, Gravity and Magnetic survey operations	2
2	Data acquisition procedures for different types of gravity and magnetic surveys (Land, marine, air-borne and space-borne), gravity gradiometry, borehole gravimetry	6
3	Working principles of Gravimeters (Absolute and Relative measurements) and Magnetometers, Operation of Gravity meters and Magnetometers, Repeatability in surveys	8
4	Principles and procedures of Geodetic positioning, Application in geophysical surveys	6
5	Survey layout, Elevation and Horizontal positioning accuracies, Standard Field Procedures, Base networks, Sources of errors in different acquisition modes	6
6	Field data recording and formatting, Overview of data reduction, Processing flow charts in standard software	6
7	Data quality check, Anomaly maps and their interpretation, Gravity studies in India, Applications in Geodynamics, resource exploration and environment and engineering aspects	8
	Total	42

List of Practicals:

1. Operation of Gravimeter and Magnetometer
2. Establishment of DGPS, Gravity, magnetic bases
3. Geodetic positioning-DGPS surveying-Static mode
4. Geodetic positioning -DGPS surveying-RTK mode
5. Geodetic data processing
6. Land gravity data acquisition
7. Land magnetic data acquisition
8. Gravity data formatting and processing
9. Magnetic data formatting and processing

11. Suggested Books:

S. No.	Name of Book/Authors	Year of Publication
1.	Gravity and Magnetic Exploration: Principles, Practices, and Applications, Hinze, W.J., Von Frese, Ralph R.B. and Saad A.H., Cambridge University Press	2013
2.	Field Geophysics, Milsom J. and Asger E., John Wiley & Sons, New York	2011
3.	Gravity and magnetic methods for Geological Studies: : Principles, Integrated Exploration and Plate Tectonics, Mishra D.C., CRC Press, Netherlands / BS Publications, Hyderabad	2011
4.	Gravity and magnetic in oil prospecting, Nettleton L.L., McGraw-Hill, New York	1976

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: DEPARTMENT OF EARTH SCIENCES

1. **Subject Code:** ESN-908 **Course Title:** Hydrogeophysics
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To infer hydrological subsurface properties, the most appropriate approach is often to use temporal changes in geophysical data that can be related to hydrological state variables. The course will provide detail understanding of geophysical techniques for advanced subsurface characterization and complex hydrogeological processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Aquifer systems**: Aquifers in alluvium formation; Aquifer in hard rock formation; Coastal aquifer system; Movement of groundwater in subsurface; Fundamental principles for groundwater modelling	8
2.	**Hydrogeological processes**: Time series analysis of the processes; Scope of hydro-environmental problems; Interaction of surface water and groundwater; Trans-boundary movement of water and associated hazardous wastes; Aquifer test using geophysical techniques	8
3.	**Geophysical techniques:** Wireline Logging for groundwater development and exploration; Surface Geophysics and Air-borne Geophysics; Electrical Resistivity Techniques; Aeromagnetic; Electromagnetic induction; Gravity and magnetic method; Seismic Refraction; Seismic Reflection; Ground Penetrating Radar	8
4.	**Hydrogeophysical mapping**: Mapping of subsurface geological features; Mapping of fault and fracture zones; Mapping of bed rocks; Mapping of seawater intrusion; Mapping of fresh-salt water interface; Cross hole measurement and well test; Hydrogeological mapping using geophysical methods	8
5.	Identification of clay content; Quantitative subsurface characterization; Recharge zone identification; Time lapse geophysical methods to study temporal changes; Saline tracer; Tracking migration of tracers	6
6.	Water sustainability; Groundwater management	4
	Total	42

11. Suggested books

S. No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	Subsurface Hydrology: Data Integration for Properties and Processes, American Geophysical Union. Book Series: Geophysical Monograph Series, Volume 171; by Hyndman David W., Day-Lewis Frederick D., Singha, Kamini	2007
2.	Groundwater Geophysics: A Tool for Hydrogeology. Springer; by Kirsch, Reinhard, K.	2009

3.	Integrated Imaging of the Earth: Theory and Applications. American Geophysical Union; by Moorkamp, M., Lelièvre P.G, Linde Niklas, Khan A.	2016
4.	Joint Inversion in Hydrogeophysics and Near-Surface Geophysics. Geophysical Monograph Series; by Moorkamp M., Lelièvre P. G., Linde N., Khan A.	2016

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Earth Sciences

1. **Subject Code:** ESN-909 **Course Title:** Modeling of Strong Motion Data
2. **Contact Hours: L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.): Theory:** 3 **Practical:** 0
4. **Relative Weightage: CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre requisite:** Basic Knowledge of Seismology
9. **Objective:** To provide understanding, processing and modelling of earthquake strong motion data

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Strong motion data and its characterization, study of some Indian strong motion database	2
2.	Properties of strong motion data, Principle of force balance accelerograph, digital and analogue strong motion recording instruments	5
3.	Recording of strong ground motion, various corrections applied for strong motion data processing, methods to remove low frequency noise	5
4.	Strong motion attenuation relations, different strong motion attenuation relations, Application of attenuation relation in hazard estimation	4
5.	Earthquake source spectra and its use in strong motion studies, Earthquake source models: Brune's model, Atkinson's model, Barrier model, Huddon's model	6
6.	Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA), Cornell's approach of probabilistic hazard, Global Seismic Hazard Assessment Program and its significance	6
7.	Importance of strong ground motion parameters in generation of synthetic strong ground motion, Stochastic simulation technique, Importance and limitation of this technique, synthetic generation of some well-known strong motion earthquake data using this technique	6
8.	Introduction to Green's function and its types, Self-Similarity laws, Simulation using Empirical Green's function technique, Mathematical treatment of empirical green's function technique, Application and Limitations of Empirical Green's function Technique, Case study of some well-known earthquakes	4
9.	Introduction to Semi-Empirical technique, Application and Limitations of Semi-Empirical Technique, synthetic generation of some well-known earthquake using this technique	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