ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

No. Acd./ 3909 /IAPC-83 Dated: June 12, 2020

Head, Department of Earthquake Engineering

The IAPC in its 83rd meeting held on 15.04.2020 vide **Item No. 83.2.3(iii)** accepted the revision in structure of following M.Tech. programs with minor modifications in the list of PECs:

(a) Soil Dynamics
(b) Structural Dynamics
(c) Seismic Vulnerability and Risk Assessment

The modified structure and syllabi are attached as **Appendix-A**.

Reeti

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

DEPARTMENT OF EARTHQUAKE ENGINEERING

M.Tech. (Soil Dynamics)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1st YEAR							**Semester- I (Autumn)**							
1.	EQN-501	Theory of Vibrations	PCC	4	3	1	2/2	3	-	15-30	20	15-25	30-40	-
2.	EQN-504	Finite Element Method	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
3.	EQN-513	Numerical Methods for Dynamic Systems	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
4.	EQN-521	Geotechnical Earthquake Engineering	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
5.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		19	12	3	1							
Semester-II (Spring)														
1.	EQN-524	Earthquake Resistant Design of Foundations	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
2.	EQN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
3.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
6.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
		Total		19-21	3	-	-							
2nd YEAR							**Semester- I (Autumn)**							
1.	EQN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	EQN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										
		Total Credits		**68-70**										

DEPARTMENT OF EARTHQUAKE ENGINEERING

M.Tech. (Structural Dynamics)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1st YEAR							**Semester- I (Autumn)**							
1.	EQN-501	Theory of Vibrations	PCC	4	3	1	2/2	3	-	15-30	20	15-25	30-40	-
2.	EQN-504	Finite Element Method	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
3.	EQN-513	Numerical Methods for Dynamic Systems	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
4.	EQN-563	Earthquake Resistant Design of Structures	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
5.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		19	12	3	1							
Semester-II (Spring)														
1.	EQN-512	Advanced Earthquake Resistant Design of Structures	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
2.	EQN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
3.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
6.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
		Total		19-21	3	-	-							
2nd YEAR							**Semester- I (Autumn)**							
1.	EQN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	EQN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										
		Total Credits		**68-70**										

DEPARTMENT OF EARTHQUAKE ENGINEERING

M.Tech. (Seismic Vulnerability and Risk Assessment)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1st YEAR							**Semester- I (Autumn)**							
1.	EQN-501	Theory of Vibrations	PCC	4	3	1	2/2	3	-	15-30	20	15-25	30-40	-
2.	EQN-513	Numerical Methods for Dynamic Systems	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
3.	EQN-531	Seismological Modeling and Simulation	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
4.	EQN-532	Vulnerability and Risk Analysis	PCC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
5.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		19	12	3	1							
Semester-II (Spring)														
1.	EQN-539	Ground Shaking Hazard	PCC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
2.	EQN-700	Seminar	SEM	2	-	-	-	-	-	-	-	-	100	-
3.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Programme Elective	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
6.		Programme Elective	PEC	3/4	-	-	-	-	-	-	-	-	-	-
		Total		19-21	3	-	-							
2nd YEAR							**Semester- I (Autumn)**							
1.	EQN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	EQN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										
		Total Credits		**68-70**										

Program Elective Courses [M.Tech. (Structural Dynamics / Soil Dynamics / Seismic Vulnerability and Risk Assessment)]

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	EQN-503	Engineering Seismology	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
2.	EQN-511	Earthquake Resistant Design of Masonry Structures	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
3.	EQN-512	Advanced Earthquake Resistant Design of Structures	PEC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
4.	EQN-514	Seismic Evaluation and Retrofitting of Structures	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
5.	EQN-515	Mechanics of Deformable Media	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
6.	EQN-519	Dynamic Soil-Structure Interaction	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
7.	EQN-521	Geotechnical Earthquake Engineering	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
8.	EQN-522	Seismic Microzonation	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
9.	EQN-524	Earthquake Resistant Design of Foundations	PEC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
10.	EQN-532	Vulnerability and Risk Analysis	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
11.	EQN-533	Seismotectonics	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	
12.	EQN-534	Advanced Seismic Microzonation	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
13.	EQN-535	Seismic Disaster Mitigation and Management	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
14.	EQN-536	Ground Failure Hazard	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
15.	EQN-537	Earthquake Precursors and Early Warning Systems	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
16.	EQN-538	Geoinformatics	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
17.	EQN-539	Ground Shaking Hazard	PEC	3	3	0	0	3	-	20-35	-	20-30	40-50	-
18.	EQN-546	Instrumentation and Model Testing Techniques	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
19.	EQN-548	Discrete Time Signal Processing	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
20.	EQN-551	Random Vibrations	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
21.	EQN-552	Reliability Based Design	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
22.	EQN-558	Advanced Structural Dynamics	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
23.	EQN-560	Earthquake Resistant Design of Bridges and Concrete Dams	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
24.	EQN-562	Dynamics of Plates, Shells and Arches	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
25.	EQN-563	Earthquake Resistant Design of Structures	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
26.	EQN-566	Structural Response Control for Seismic Protection	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
27.	EQN-571	Ground Improvement Techniques	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
28.	EQN-572	Machine Foundation	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-

29.	EQN-576	Seismic Slope Stability: Earth Dams Retaining Walls	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
30.	EQN-577	Constitutive Modeling in Soil Dynamics	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
31.	EQN-584	Engineering Applications of Geophysical Techniques	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-
32.	EQN-590	Strong Motion Seismology	PEC	4	3	1	0	3	-	20-35	-	20-30	40-50	-

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Earthquake Engineering

1. **Subject Code:** EQN-501 **Course Title:** Theory of Vibrations
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 2/2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 15-30 **PRS:** 20 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Autumn **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide the basic framework for studying time-dependent response of mechanical systems to external excitations.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Vibrations and the nature of time dependent phenomena, inertia, dynamic equilibrium and mathematical models of physical systems; Energy storing and dissipation mechanisms.	2
2.	Dynamics of Single Degree of Freedom Systems, undamped and damped, free and forced vibrations; Steady-state and transient response, impulse response.	9
3.	Harmonic response and applications to vibration isolation; theory of seismic pickups: Seismometers, accelerometers.	4
4.	Convolution integral and solution of equation of motion; Numerical methods for solution of linear and non-linear equations of motion; response/shock spectra; Fourier transforms and analysis in frequency domain.	6
5.	Dynamics of Multi-Degree of Freedom Systems**,** Lagrange's equations; equations of motion for MDOF systems; Algebraic eigenvalue problem and free vibration analysis; Undamped and damped normal modes; Mode superposition method for dynamic analysis of linear systems; Mode- truncation and correction for the missing mass.	9
6.	Dynamics of Continuous Systems**,** Hamilton's principle, Axial and transverse vibrations of beams, Normal modes: Free and forced vibration analysis by mode superposition	3
7.	Probability Theory and Stochastic Processes: Random variables, functions of random variables, correlation, stationary and ergodic random processes, power spectrum	4
8.	Response of SDoF and MDoF Systems to Random Excitations: Time domain characterization, frequency domain analysis, estimation of maximum response	5
	Total	42

List of Experiments:

1. Vibration transducers and elementary data processing.
2. Free vibration characteristics of structural systems-natural frequency and damping ratio.
3. Harmonic forced vibration response of structural models and frequency response functions.
4. Dynamic vibration absorber.
5. Prototype testing and system identification.

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/Reprint
1.	Warburton, G.B., "The Dynamic Behaviour of Structures", 2nd edition, Pergamon Press.	1976
2.	Clough, R. W. and Penzien., J., "Dynamics of Structures", 2nd edition, Mc-Graw Hill Book Company.	1993
3.	Humar, J.L., "Dynamics of Structures", 2nd edition, Taylor & Francis.	2002
4.	Chopra, A. K., "Dynamics of Structures", 3rd edition, PHI Learning.	2006
5.	Craig, R. R., Jr. and Kurdila, A., "Fundamentals of Structural Dynamics", 2nd edition, John Wiley & Sons.	2006
6.	Villaverde, R., "Fundamental Concepts of Earthquake Engineering", Taylor & Francis.	2008
7.	Nigam N.C., Introduction to Random Vibrations, MIT Press.	1983
8.	Wirsching, P.H., Paez, T.L. and Ortz, H., "Random Vibration", Dover Publications	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Earthquake Engineering

1. **Subject Code:** EQN-503 **Course Title:** Engineering Seismology
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:** Spring **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the relevant principles and prevalent practices in Engineering Seismology from Earthquake Engineering viewpoint.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction:** Scope of seismology; Definitions of important terms; Internal structure of earth; Causes of earthquakes and their classifications; Primary and secondary effects, ground deformation and structural damages during great Indian earthquakes.	6
2.	**Plate Tectonics and Seismicity:** Plate tectonics and continental drift theory and supporting evidences; Plate driving forces; plate margins and earthquake occurrences; Global and Indian seismicity.	6
3.	**Seismic Wave Propagation:** Theory of elasticity; Wave equation; Body and surface waves; Laws of reflection, refraction, attenuation, diffraction and dispersion; Source, path and local site effects on ground motion; Seismic phases.	8
4.	**Seismic Instrumentation:** Earthquake recordings– principles and theory of seismograph; Various kinds of seismographs; Analog and digital recording, WWSSN, GDSM; Real time warning system; International monitoring system (IMS); Local seismological networks, strong motion networks and their engineering importance; Processing, analysis and interpretation of seismograms.	6
5.	**Earthquake Parameters:** Earthquake magnitude and intensity scales; Engineering importance of isoseismal maps; Earthquake energy, frequency-magnitude relations and return period. Estimation of earthquake epicenter, focal depth, origin time and fault plane solutions.	6
6.	**Seismic Hazard Assessment:** Definitions- seismic hazard, disaster and risk; Probabilistic and deterministic approach; Earthquake occurrence models; Seismotectonic modeling and type of sources; Estimation of maximum magnitude, maximum credible earthquake, design basis earthquake; Frequency magnitude relationship; Poissonian and Non Poissonian models; Ground motion prediction equations; Uncertainties in seismic hazard assessment and their quantification; Return periods and strong motion exceedance rates; Site-specific design earthquake parameters.	10
	Total	**42**

List of Experiments:

1. Installation and operation of seismograph to record ground motion.
2. Calibration of seismograph to compute its response.
3. Background noise survey for selection of site.
4. Interpretation of seismograms and estimation of source parameters.

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/Reprint
1.	Bullen, K.E. and Bolt, B.A., "An introduction to the Theory of Seismology", Fourth Edition, Cambridge University Press, Cambridge.	1985
2.	Kulhanek, O., "Anatomy of Seismograms", Elsevier Science Publication.	1990
3.	Lay Thorne and Wallance Terry C., "Modern global seismology", Academic press.	1995
4.	William Lowrie, "Fundamentals of Geophysics", Cambridge, Univ. Press.	1997
5.	Kramer, S.L., "Geotechnical Earthquake Engineering", Second Indian reprint, Pearson Education.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Earthquake Engineering

1. **Subject Code:** EQN-539 **Course Title:** Ground Shaking Hazard
2. **Contact Hours:** **L:** 3 **T:** 0 **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:** 3 **6. Semester:** Both **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** This course is designed to provide the necessary conceptual and analytical background for seismic hazard assessment.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction:** Earthquake & Hazard, Primary and secondary hazards, landslide and tsunami, deterministic and probabilistic approaches, tectonic features and seismotectonic modelling, earthquake sources, estimation of maximum magnitude, maximum credible earthquake, design basis earthquake, maximum probable earthquake.	4
2.	**Seismicity Data and Treatment:** Seismicity catalogues, spatial coverage, temporal coverage, completeness in size and time, cut off magnitude, earthquake swarm, foreshocks and aftershocks, declustering of data, homogenization of catalogue, bivariate orthogonal regression, estimation of maximum probable magnitude.	8
3.	**Earthquake Occurrence Models:** Gutenberg Richter frequency magnitude distribution, return period; Poissonian model, time dependent Poisson process, characteristic earthquake model, periodicity, conditional probabilities, Gamma distribution, Weibul distribution, Gaussian distribution, log normal distribution, Markov and semi-Markov models, Gumbel distributions and mixed Gumble distribution; Time and slip predictable earthquake models.	10
4.	**Ground Motion Prediction Equations:** Strong motion attenuation relationships, dependent and independent parameters, PGA and spectral accelerations, elastic and inelastic response spectra, displacement spectra, periods of interest.	8
5.	**Deterministic and Probabilistic Seismic Hazard Analysis:** Deterministic and probabilistic seismic hazard methods; Types of earthquake sources: point, line and areal sources, random seismicity method, seismotectonic providence method, geological slip rate method, Zone free seismic hazard estimation: Epistemic and aleatory uncertainty estimation, deaggregation, logic tree, hazard estimation at the bedrock level, various types of iso acceleration maps, probability of exceedance and return periods in earthquake engineering; Monte Carlo simulations.	12
	Total	42

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/Reprint
1.	Kramer, S.L., "Geotechnical Earthquake Engineering", Pearson Education.	1996
2.	Chernick, M.R., "Bootstrap methods: A practitioner's guide, in Wiley Series in Probability and Statistics", W.A. Shewhart (Editor), John Wiley and Sons.	1999
3.	Reiter, L. "Earthquake Hazard Analysis, Issues and Insights", Columbia University Press.	2001
4.	Stein, S. and Wysession, M., "An Introduction to Seismology, Earthquake and Earth Structures", Black Well Publications.	2003
5.	McGuire, Robin K., "Seismic Hazard and Risk Analysis", Earthquake Engineering Research Institute.	2004
6.	Draper, N.R. and Smith, H., "Applied regression analysis", John Wiley and Sons (Asia).	2005