SYLLABUS

Master of Technology

Earthquake Engineering

M Tech

Department of Civil Engineering

Faculty of Engineering & Technology

Jamia Millia Islamia

New Delhi - 110025 (INDIA)

www.jmi.ac.in

SYLLABUS

MASTER OF TECHNOLOGY (M. Tech.)
EARTHQUAKE ENGINEERING

Department of Civil Engineering
Faculty of Engineering & Technology
JamiaMilliaIslamia
New Delhi – 110025 (India)
http://www.jmi.ac.in/
July 2011

Preface

Civil Engineering is the oldest branch in the engineering and technological field with its versatility in application. Earthquake Engineering is an important specialization in Civil Engineering as seismic analysis and design is essential component for the safe Civil Engineering structures. The M. Tech. in Earthquake Engineering program is one of the newest programs of the department and started in the year 2011. This specialized post graduate program is being offered by very few institution of the country.

The human needs are being upgraded rapidly with time and new technology and products are being produced to meet the requirements. To keep the pace with time, the syllabus of M. Tech. (Earthquake Engineering) program is devised in the present form based on the suggestions of experts, academicians, persons working in the industry and researchers and on the feedback of the stakeholders. The latest trend in the industry and research field is combined with advanced knowledge of each subject while making the syllabus. The courses will help the students to make strong base for working in academic, research and industry environment.

The course consists of theoretical and laboratory components with seminar presentation and dissertation which will give the opportunity to the students to develop their skills in the field of Earthquake Engineering. The program consists of core course as well as elective courses. The elective courses are designed; provide the flexibility to students to choose on their choices. The latest softwares related to the various courses are available in the software laboratory to make the student abreast.

I wish to acknowledge the hard work put in by the faculty members in the updating and revision of syllabus. I also wish to convey my sincere thanks to the subject experts who gave their valuable inputs in finalizing this syllabus.

Professor Mohammad Shakeel
Head

About The University

Jamia Millia Islamia, an institution originally established at Aligarh in United Provinces, India in 1920 became a Central University by an act of the Indian Parliament in 1988. In Urdu language, Jamia means 'University', and Millia means 'National'.

The story of its growth from a small institution in the pre-independence India to a central university located in New Delhi—offering integrated education from nursery to research in specialized areas—is a saga of dedication, conviction and vision of a people who worked against all odds and saw it growing step by step. They "built up the Jamia Millia stone by stone and sacrifice by sacrifice," said Sarojini Naidu, the nightingale of India.

Under the colonial British rule, two dominant trends joined hands and contributed towards in the birth of Jamia. One was the anti-colonial Islamic activism and the other was the pro-independence aspiration of the politically radical section of western educated Indian Muslim intelligentsia. In the political climate of 1920, the two trends gravitated together with Mahatma Gandhi as a catalyst. The anti-colonial activism signified by the Khilafat and the pro-independence aspirations symbolised by the non-cooperation movement of the Indian National Congress helped to harness creative energies and the subsequent making of Jamia Millia Islamia. Rabindranath Tagore called it "one of the most progressive educational institutions of India".

Responding to Gandhiji's call to boycott all educational institutions supported or run by the colonial regime, a group of nationalist teachers and students quit Aligarh Muslim University, protesting against its pro-British inclinations. The prominent members of this movement were Maulana Mehmud Hasan, Maulana Mohamed Ali, Hakim Ajmal Khan, Dr. Mukhtar Ahmad Ansari, and Abdul Majid Khwaja. Hakim Ajmal Khan, Dr. Mukhtar Ahmed Ansari and Abdul Majeed Khwaja supported by Gandhiji shifted Jamia from Aligarh to Karol Bagh, in New Delhi in 1925. In 1925, after long deliberation, a group of three friends studying in Germany—Dr. Zakir Husain, Dr. Abid Husain and Dr. Mohammad Mujeeb—decided to serve Jamia.

One of the first steps they took was the introduction of the hugely popular evening classes for adult education. This movement was later to become, in October 1938, an institution called Idara-i-Taleem-o-Taraqqi.

In 1928 Hakim Ajmal Khan passed away. That was the beginning of the second financial crisis, as it was Hakim Sahib himself who had been meeting most of Jamia's

financial needs. The leadership of Jamia then moved into the hands of Dr. Zakir Husain, who became its Vice Chancellor in 1928. To resolve Jamia of these frequent crises, a group of young Jamia teachers, led by Dr. Zakir Husain, took a pledge to serve Jamia for the next twenty years on a salary not more than Rs. 150. This group was called the Life Members of Jamia. (History repeated in 1942 when a second group of Jamia teachers took a similar pledge).

Jamia's department of Printing and Publications was trifurcated in 1928 with the newly established Jamia Press at Darya Ganj, Urdu Academy, and Maktaba Jamia under the charge of Prof. Mohammad Mujeeb, Dr. Abid Husain and Mr. Hamid Ali respectively.

On 1st March 1935, the foundation stone for a school building was laid at Okhla, then a non-descript village in the southern outskirts of Delhi. In 1936, all institutions of Jamia, except Jamia Press, the Maktaba and the library, were shifted to the new campus. The basic emphasis of Jamia was on evolving innovative education methods. This led to the establishment of a teacher's college (Ustadon ka Madrasa) in 1938.

The fame of Jamia as an innovative education movement spread and dignitaries from foreign countries began visiting Jamia. Husein Raouf Bey (1933), Dr. Behadjet Wahbi of Cairo (1934), Ms. Halide Edib of Turkey (1936) were some of them. Foreigners, impressed by Jamia, began working in Jamia. The German lady Ms. Gerda Philipsborn (popularly known as Aapa Jaan) served Jamia for many years is buried in Jamia.

In 1939, Maulana Ubaidullah Sindhi (1872-1944), a theologian and freedom fighter, came to stay in Jamia on the invitation of Dr. Zakir Husain. He started a school of Islamic Studies in Jamia, called Baitul Hikmal, propagating the ideology of Shah Waliullah. Zakir Husain, later the President of India, recalled those days of indestructible optimism in the face of depravity 'when they had a longing to build and nothing to build with, as "days of joy".

After the attainment of Independence, Jamia continued to grow as an academic institution with a difference. Many foreign dignitaries made it a point to visit Jamia Millia Islamia during their visits to New Delhi. Among those who visited Jamia include Marshal Tito (1954), king Zahir Shah of Afghanistan (1955), crown prince Faisal of Saudi Arabia, king Reza Shah Pehlavi of Iran (1956) and prince Mukarram Jah (1960).

In 1962, the University Grants Commission declared the Jamia a 'deemed to be University'. Soon thereafter, the School of Social Work was established in 1967. In

1971, Jamia started the Zakir Husain Institute of Islamic Studies, to honour Dr. Zakir Husain, who had passed away in 1969. BE course in Civil Engineering commenced in 1978; in 1981, the faculties of Humanities and Languages, Natural Sciences, Social Science, and the State Resource Centre were founded. In 1983, it started the Mass Communication Research Centre and the Centre for Coaching and Career Planning. In 1985, it established the Faculty of Engineering & Technology and the University Computer Centre. Academic Staff College and the Academy of Third World Studies followed in 1987 and 1988.

By a Special Act of the Parliament, Jamia Millia Islamia was made a central university of India in December 1988.

At present Jamia has Nine faculties and a number of centres of learning and research, like AJK-Mass Communication Research Centre (MCRC), Academy of International Studies etc. The Jamia is also marching ahead in the field of Information Technology (IT). It offers various undergraduate and postgraduate IT courses. Apart from this, the Jamia has a campus wide network which connects a large number of its departments and offices.

About the Department

The Department of Civil Engineering is one of the oldest and the largest department in the Faculty of Engineering & Technology. The department has produced several eminent engineers who have made important contributions in the planning and execution of many important Civil Engineering projects in India as well as abroad.

The Department offers two undergraduate courses in Civil Engineering. The Department also offers Master's programme with specialisations in Environmental Engineering and Earthquake Engineering .In all, there are around 560 students in undergraduate programme and 75 students pursuing their Masters degree. These courses are supported with strong doctoral programmes in all the major specialisations of Civil Engineering. More than 45 Ph. D. research scholars including many from foreign countries are currently working in the department on emerging research areas.

The Department is known for its reputed faculty with expertise in diverse fields. Presently, the department has 23 highly qualified, experienced, sincere and dedicated teaching faculty members, actively participating in research and consultancy work. During last 5 years, faculty members have published more than 280 papers in reputed refereed International Journals.

Over a period of time, the Department has built up a wide research potential. The research programmes of the department are funded by various agencies such as Ministry of Human Resource Development (MHRD), Department of Science & Technology (DST), Ministry of Environment & Forests (MoEF), Central Pollution Control Board (CPCB), All India Council of Technical Education (AICTE), University Grants Commission (UGC), Ministry of Steel and Ministry of Urban Development. Major area of research in the Department include; Sustainable Development, low cost sanitation, water treatment, air, noise and water quality modelling, Reuse of concrete, application of GIS and remote sensing in water resources and environment, Vulnerability assessment, Seismic analysis of structures, retrofitting, Soil structure interaction, Hydro-climatology, Water resource assessment and management.

The Department has established a state of the art experimental facilities and laboratories in different fields of Civil Engineering. It has received the prestigious funding under FIST from DST and SAP from UGC. The Department has mobilized more than Rs 250 millions from various external agencies to carry out research in cutting edge technologies in different fields of Civil Engineering.

The faculty also renders technical advice on live engineering problems to various Government and Private Sector companies throughout the country. These live projects are effectively used as training desk for our students at undergraduate and postgraduate levels. RITES, Military Engineering Services, Municipal Corporations of Delhi, Faridabad, Gurgaon, Gaziabad, NOIDA, PWD, CPWD, DDA, HUDA, Jal Nigam etc. regularly hire services for technical advice and vetting of designs of infrastructure projects. The Department has generated around Rs 800 million through consultancies during the last five years.

International and national conferences, seminars and special lectures are a regular feature of the Department to impart education and training. The Department has active collaboration with academics and industry such as University of Applied Sciences Erfurt (Germany), Wessex Institute (UK), University of Waterloo (Canada), Asian Institute of Technology (Bangkok) and Steel Authority of India (INDIA).

Leading MNCs and public sectors are regular recruiter of our students and many students have been selected in Engineering Services. Several of our alumni pursued higher education in USA, UK, Germany, Canada, Australia and France and have been appointed as faculty members and consultants abroad.

The Department strongly believes in continuous efforts to strive for excellence by exploring new frontiers of knowledge, imparting the latest technical knowledge to the students and conducting high quality research.

Program Educational Objectives

The **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)** are the statements that describe the expected achievements from the programme. They are guided by global and local needs, the vision of the department, long term goals etc. The Programme Educational Objectives of M-Tech in Earthquake Engineering includes:

1. The graduates will engage in the technical education of Earthquake Engineering across a range of application areas including analysis and design of earthquake resistant structures, computational methods etc.
2. The graduates will experience successful careers and provide leadership and will have an ability to continuously adapt to meet the challenges of a changing environment.
3. The graduates will be well prepared for pursuing further studies in India and abroad as well.
4. The graduates will be groomed to serve the society and country by making new products, technology and software.
5. The graduates will be prepared to lead the academic, research organizations and consultancies.

Program Outcomes

The curriculum and syllabus for M-Tech Earthquake Engineering program conform to result oriented teaching learning process. In general, **TEN PROGRAM OUTCOMES (POs)** have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Program outcomes are statements that describe significant and essential learning that students have achieved, and can reliably demonstrate at the end of a course or program.

Students of the earthquake engineering program will be able to:

1. Apply knowledge of mathematics, science, and engineering to solve the problems related to Earthquake Engineering.
2. Design and conduct experiments of structural dynamics and seismology, to solve the engineering problems many latest softwares, and analyze the experimental data.
3. Design earthquake resistant structures considering safety, efficiency, elegance and economy
4. Work in engineering and non-engineering multidisciplinary teams to complete an assigned project.
5. Identify, formulate with mathematical modelling, and solve the engineering problems using different computational tools and perform laboratory experiments (if required).
6. Understand professional and social responsibility and understand the impacts of engineering solution on the society, environment, country, and on universe as well.
7. Communicate efficiently in their profession and career with team members, colleagues and with the society at large orally, in writing and presentation.

8. Identify new problems for research, solution and application of the problems, ability to update the latest knowledge in research and industry, ability to go for higher studies and research organization and in the consultancy.
9. Apply the knowledge to study latest events of earthquake and adopt new methodology for analysis and earthquake resistant design of structures with latest architecture and materials.
10. Apply the knowledge to run the latest software related to analysis and design of structures, develop new software in this field including new techniques, tools and practices.

Course Structure

First Semester

Course No.	Course Title	Credit	*Period per week*			*Marks*		
			L	**T**	**P**	***Mid Sem***	***End Sem***	**Practical**
MEQ-101	Advance Structural Analysis	4	3	1	--	40	60	--
MEQ -102	Theory of Vibrations	4	3	1	--	40	60	--
MEQ- 103	Finite Element Method	4	3	1	--	40	60	--
MEQ-104	Seismology and Geotechnical Earthquake Engineering	4	3	1	--	40	60	--
MEQ-105	Analysis and Design of Tall Buildings	4	3	1	--	40	60	--
MEQ-150	Structures / Seismology Laboratory	3	--	--	6	45	--	30
Total		**23**	**15**	**5**	**6**	**245**	**300**	**30**
Total credit = 23			**Total Periods Per week = 26**			**Total Marks = 575**		

Second Semester

Course No.	Course Title	Credit	*Period per week*			*Marks*		
			L	**T**	**P**	***Mid Sem***	***End Sem***	**Practical**
MEQ-201	Optimization Techniques	4	3	1	--	40	60	--
MEQ -202	Fundamental of Earthquake Analysis	4	3	1	--	40	60	--
MEQ -203	Earthquake Resistant Design of Structures	4	3	1	--	40	60	--
MEQ -204	Elective – I	4	3	1	--	40	60	--
MEQ -205	Elective - II	4	3	1	--	40	60	--
Total		**23**	**15**	**5**	**0**	**200**	**300**	**--**
Total credit = 23			**Total Periods Per week = 20**			**Total Marks = 500**		

Third Semester

Course No.	Course Title	Credit	*Period per week*			*Marks*		
			L	**T**	**P**	***Mid Sem***	***End Sem***	**Practical**
MEQ-301	Advance RCC Design	4	4	-	-	40	60	--
MEQ-304	Seminar	2	-	-	4	-	--	50
MEQ-305	Dissertation	6	-	6	6	90	--	60
MEQ-302	Software Laboratory	2	-	-	6	30	--	20
MEQ-303	Structural Dynamics Lab	3	-	-	6	45	--	30
Total		**17**	**4**	**6**	**22**	**205**	**60**	**160**
Total credit = 17			**Total Periods Per week = 32**			**Total Marks = 425**		

Fourth Semester

Course No.	Course Title	Credit	*Period per week*			*Marks*		
			L	**T**	**P**	***Mid Sem***	***End Sem***	**Practical**
MEQ-401	Dissertation	12	-	12	12	180	120	--
Total		**12**	**--**	**12**	**12**	**180**	**120**	**--**
Total credit = 12			**Total Periods Per week = 24**			**Total Marks = 300**		

FIRST SEMESTER

ADVANCE STRUCTURAL ANALYSIS

Paper Code	**MEQ -101**	**(Lectures-Tutorial-Practical)/Week**	**(3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total)**	**(40-60-100)**

Course Objectives

- To make clear understanding for idealization of various structural forms and supports to carry different lo0adings
- To make the students understand basic methods of structural analysis of framed structures, Plates and Shells to interpret the results obtained from software analyses.
- To perform manual analysis of structures and compare them with those obtained from software

Course Learning Outcome

- Will be able to Idealize structures and their supporting system
- Will have clear understanding of the response of the structures under different loadings
- Will be able perform analysis of structures confidently

Course Description

Unit-I

Methods of Structural Analysis, Structural idealization, Types of Framed Structures, Deformations in Framed Structures, Actions and Displacements, Static and Kinematic Indeterminacy, Actions and Displacement Equations, Flexibility and Stiffness Matrices, Equivalent Joint Loads, Energy Concepts and Virtual Work

Unit-II

Flexibility Method, Temperature Changes, Pre strains, Support Displacements, Joint Displacements, Member End Actions, Support Reactions, Formalization of Flexibility Method

Unit-III

Stiffness Method, Temperature Changes, Pre strains, Support Displacements, Joint Displacements, Formalization of Stiffness Method, Direct Stiffness Method, Formation of Joint

Stiffness Matrix, Formation of Load Vector, Rotation of Axes in Two Dimensions, Rotation Matrix, Rotation Transformation Matrix, Rotation of Axes in Three Dimensions, Rectangular Framing, Use of Symmetry and Anti-symmetry, Loads Between Joints and Transfer Matrix, Oblique Supports and Elastic Supports, Member Stiffnesses and Fixed End Actions from Flexibilities, Non prismatic and Curved Members, Discontinuities in Members, Shearing Deformations

Unit-IV

Plastic Analysis, Introduction, Elastic Analysis versus Plastic Analysis, Ultimate Moment, Newton Raphson's Technique Plastic response of a Simple Beam, Ultimate Strength of Fixed and Continuous Beams, Rectangular Portal Frames, Plastic Hinge under Distributed Loads, Frames with Inclined Members, Effect of Axial Load and Shear on Plastic Moment Capacity, Nonlinear Analysis, Geometric Stiffness Matrix, Modified Newton Raphson's Technique

Unit-V

Thin and Thick Plates, Kirchoff-Love Plate Theory of Thin Plates, Navier's and Levi's Solutions, Numerical and Approximate Methods, Deformations of Shells without Bending

Text Books

- Matrix Analysis of Framed Structures, William Weaver Jr. and James M. Gere, CBS Publidhers
- Structural Analysis, A. Ghali and A. m. Neville, E & FN SPON

Reference Books

- Analysis and Behaviour of Structures, Rossow, G.C, Prentice Hall
- Analysis of Structural Systems, Fleming, J. F., Prentice Hall

Software or other Requirement

- STAAD PRO
- ETAB

THEORY OF VIBRATIONS

Paper Code	**MEQ-102**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To impart fundamentals of structural dynamics to M. Tech students in Earthquake Engineering.
- To teach them solution techniques used for solving dynamic problems.
- To prepare them for understanding seismic analysis of structures offered in the subsequent semester.
- To offer them the ability to think and handle real life dynamic problems.

Course Learning Outcome

- Will acquire knowledge of the fundamentals of structural dynamics.
- Will be able to pursue advanced level courses in dynamics and in related application areas.
- Will be able to handle real life dynamic problems.

Course Description

Unit-I

Sources of dynamic loading, concepts of oscillation and SHM, inertia force, restoring force, damping force, modeling of damping, free and forced vibration of SDOF, determination of damping co-efficient

Unit-II

Solution of equation of motion of SDOF in time & frequency domains for irregular loading, FRF, transient dynamics, support motions

Unit-III

Equations of motion of MDOF system, generation of stiffness matrix for dynamic d.o.f, eigen-value problem, mode shapes & frequencies, support motions, solution for irregular loading in time and frequency domain

Unit-IV

Normal mode theory, mode acceleration approach, solution using FFT and IFFT, FRF,

solution for irregular support motion, modal response spectrum analysis

Unit-V

Continuum system, Rayleigh's method for approx frequency calculation, normal mode analysis, wave propagation analysis

Text Books

- Dynamics of Structures; R.W. Clough and J. Penzien; McGraw Hill (Student Edition)
- Dynamics of Structures: Application to Earthquake Engineering; Prentice Hall (Student Edition)
- Theory of Vibration with Application; W.T. Thomson; Prentice Hall

Reference Books

- Dynamics of Structures, Hurtey, W.C. and Rubinstein, M.F.; Prentice Hall
- Structural Dynamics for Structural Engineers, Hart, G.C., Wong, K.K.F., and Wong, K.; John Wiley
- Siesmic Analysis of Structures; Datta, T.K.; John Wiley

FINITE ELEMENT METHOD

Paper Code	**MEQ- 103**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- Develop the finite element equations to model engineering problems
- Apply finite element method to formulate and solve structural problems
- Solve differential equations using the approximate numerical methods

Course Learning Outcome

- Students will be able to use concept of science, engineering and mechanics in the subject
- Students will be able to use the concept of the subject for using FEM softwares
- Students will be able to identify, formulate and solve engineering problems applying FEM

Course Description

Unit-I

Introduction, brief history, general steps in FEM, applications, advantages; Introduction to the stiffness method, definition of stiffness matrix for a spring element, assemblage, assembling the total stiffness matrix by superposition (direct stiffness method), boundary conditions, potential energy approach to drive spring element equations; Development of truss equations: development of stiffness matrix for a bar element in local coordinates, approximate functions for displacement, transformation of vector in 2D, global stiffness matrix, computation of stress for a bar in 2D plane, solution of a plane truss, transformation matrix & stiffness matrix for a bar in 3D space, use of symmetry in structures, inclined supports, Galerkin's residual method.

Unit- II

Development of Beam Equations: Introduction, beam stiffness, assemblage of beam stiffness matrices, distributive loading, beam element with nodal hinge; Frame & Grid Equations: introduction, 2D arbitrarily oriented beam element, rigid plane frames, inclined support-frame elements, grid equation, beam element arbitrarily oriented in space, sub structure analysis; Plane

stress & plain strain, basic concept, derivation of constant strain triangular element stiffness matrix & equations, body & surface forces, explicit expression for CST stiffness matrix, FEM solution of a plane stress problem

Unit- III

Finite element modeling, equilibrium & compatibility of finite element results, static condensation, development of linear strain triangle equations, derivation of LS triangular element stiffness equation, axisymmetric elements, derivation of stiffness matrix; Isoparametric Formulation; bar element stiffness matrix, rectangular plane stress element, plane element stiffness matrix, higher order shape functions.

Unit- IV

3D stress analysis, tetrahedral element, isoparametric formulation; Plate Bending Element: basic concept of plate bending, derivation of plate bending element stiffness matrix & equations; Heat transfer and mass transport: derivation of basic equations, 1D FE formulation, FE formulation of heat transfer with mass transport; Fluid flow in porous media and through hydraulic networks: Derivation of basic equations, 1D FE formulation; Electrical Networks and Electrostatics.

Unit- V

Thermal stress, formulation of thermal stress problems; Structural Dynamics: determination of bar element equations, natural frequency of 1D bar, beam element mass material & natural frequencies, truss, plane frame, plane stress/strain axisymmetric & solid element mass matrix

Text Books

- Finite Elements and Approximation, Zienkiewicz, O. C. and Morgan, K., John Wiley & Sons
- Finite Element Method, Reddy, J.N., McGraw-Hill Book Company
- Finite Element Procedures, Bathe, K. J., PHI Learning

Reference Books

- A Unified Approach to the Finite Element Method and Error Analysis Procedures, Dow, J.O., Elsevier.
- Concepts and Applications of Finite Element Method, Cook, R.D., Malkus, D., Plesha, M. and Witt, J., John Wiley & Sons

Software or other Requirement

- ANSYS
- ABAQUS
- MATLAB, STAAD PRO

SEISMOLOGY AND GEOTECHNICAL EARTHQUAKE ENGINEERING

Paper Code	**MEQ-104**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- Provide the students with an introduction of seismology and advanced level understanding of the mechanisms of earthquakes and measurement of strong ground motions
- Enable the students to conduct ground response analysis
- Enable the students to perform seismic slope stability analysis/design
- To study the seismological activity of the earth in response to sub-surface strata
- Micro-zonation analysis of different earthquake zones in India.

Course Learning Outcome

- Have advanced understanding of seismology, including plate tectonics, faults, waves induced by earthquakes, and size of earthquakes
- Be able to use strong ground motion data in earthquake engineering analysis/design
- Be able to perform site response analysis
- Be able to evaluate liquefaction resistance and assess liquefaction potential using field data

Course Description

Unit-I

Introduction to the hazards of earthquakes: strong ground motions, tsunamis, landslides, liquefaction. Review of plate tectonics. Seismic hazard in Puerto Rico and beyond; Maths review: Fourier Transforms Single degree of freedom dynamics, damped vibrations. Convolutions, Green's Functions; A seismic station: sensors and data loggers. Poles and zeros for sensor response; Mechanical and digital sensor design and performance

Unit-II

Interpretation of Seismic Records - acceleration, velocity and displacement; Issues with strong

ground motions and record parameterisation; Theory of wave propagation: Body waves Theory of wave propagation: Surface waves

Unit-III

Dynamic Soil Properties: Stress & strain conditions, concept of stress path; Measurement of seismic response of soil at low and high strain, using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, dynamic plate load test, block vibration test, SASW/MASW tests, cross bore hole; Evaluation of damping and elastic coefficients; Stress-strain behavior of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear and cyclic nonlinear models; Static and dynamic characteristics of soils.

Unit-IV

Background and lessons learnt from damages in past earthquake; Wave in infinite & semi-infinite media –one, two and three dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, wave in a layered media; Determination of Dynamic Soil Properties as per IS-5249; Ground Response Analysis: Introduction one, two and three dimensional analyses; Introduction to soil-structure interaction

Unit-V

Evaluation of liquefaction potential: characterization of earthquake loading and liquefaction resistance, cycle stress ratio, Seed and Idress method; Effects liquefaction; Seismic design of retaining walls: types, modes of failure, static pressure, seismic response (including M-O method), seismic displacement, design consideration; Types of earthquake induced landslides; Evaluation of slope stability: stability analysis with dynamic loading, friction circle method, effective and total stress methods of analysis, yield acceleration, damage potential, displacement analysis, effect of saturated and submerged conditions, FEM analysis of slope stability

Text Books

- International Handbook of Earthquake and Engineering Seismology. Lee, W.H.K, Kanamori, H., Jennings, P.C., Kissinger, C., Academic Press
- Introduction to Seismology. Shearer, P. M., Cambridge University Press
- Geotechnical Earthquake Engineering. Kramer, S. L., Prentice Hall
- Soil Dynamics, Prakash, S., McGraw Hill Book Company.

Reference Books

- An Introduction to Seismology, Earthquakes and Earth Structure. Stein, S. and Wysession, M., Blackwell Publishing
- Modern Global Seismology. Lay, T., and Wallace, T. C., Academic Press

ANALYSIS AND DESIGN OF TALL BUILDING

Paper Code	**MEQ - 105**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To familiarize students with the recent developments in seismic analysis and design of tall buildings from the perspective of efficient use in design offices leading to latest research in this area like prescriptive design methods and modern performance-based design methods for tall buildings
- Understand common structural systems utilized in tall buildings and their design philosophy.
- Perform preliminary design and analysis of various structural systems for tall buildings.

Course Learning Outcome

- Develop analytical models for tall buildings using latest structural analysis programs, and to assess structural response under seismic excitation using such analytical tools..
- Effectively participate in structural design of tall buildings for specified performance objectives at component and system levels.

Course Description

Unit-I

Structural system and concept; Approximate methods for analysis of multistoried frames; Analysis of symmetric frames, mass irregularities in plane and elevation; Analysis for torsions in buildings

Unit-II

Design of building with shear walls and coupled walls; Effect of openings; Design specifications and I.S. codes

Unit-III

Behavior of framed tube systems, tube in tube system and blended tube system; Simplified analytical models for symmetrical tubular structures

Unit-IV
Design of Raft and Pile Foundations

Text Books

- Tall Building Structures: Analysis and Design, Bryan Stafford Smith & Alex Coull, Wiley India Pvt. Ltd.
- Foundation Engineering, P.C. Varghese, PHL Learning Private Limited.
- High Rising Building Structures, Wolfgang Schueller, Robert E. Krieger Publishing Company.
- Reinforced Concrete Structures, Arthur, H.N., McGraw-Hill.

Reference Books

- Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, Bungale S. Taranath, CRC Press
- Structural Analysis, A. Ghali and A.M. Neville, E & FN SPON
- The Seismic Design Handbook, Farzad Naeim, Kluwer Academic Publishers.
- Handbook of Concrete Engineering Author:- Mark Fintel, Publication:- CBS Publications & Distributors

Software or other Requirement

- STAAD
- ETAB
- SAP
- ANSYS

SECOND SEMESTER

OPTIMIZATION TECHNIQUES

Paper Code	**MEQ -201**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To make clear understanding of various Optimization Techniques and Optimality Criteria.
- To make the students understand basic methods of Optimization such as Powell's conjugate direction method, Simplex method. Gradient based methods: Cauchy's (Steepest descent) method, Conjugate gradient method, Newton's method, Variable metric (DFP) method, BFGS method.
- To make the students understand Constrained Optimizations Techniques
- To understanding of various Specialized Optimizations techniques ¾ Dynamic programming, Geometric programming, Genetic Algorithms

Course Learning Outcome

- Will be able to optimize structures and their supporting system
- Will have clear understanding of basic methods of Optimization
- Will be able to understands the Specialized Optimizations techniques

Course Description

Unit-I

I**ntroduction**; Problem formulation with examples; Single Variable Unconstrained Optimizations Techniques ¾ Optimality Criteria. Bracketing methods: Unrestricted search, Exhaustive search, Region Elimination methods: Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method.

Unit-II

Interpolation methods: Quadratic Interpolation method, Cubic Interpolation method; Gradient Based methods: Newton-Raphson method, Secant method, Bisection method. Multi Variable Unconstrained Optimisation Techniques ¾ Optimality Criteria, Unidirectional Search. Direct Search methods: Random search, Grid search, Univariate method, Hooke's and

Jeeves' pattern search method, Powell's conjugate direction method, Simplex method.

Unit-III

Gradient based methods: Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher-Reeves) method, Newton's method, Variable metric (DFP) method, BFGS method. Constrained Optimisation Techniques ¾ Classical methods: Direct substitution method, Constrained variation method, method of Lagrange multipliers, Kuhn-Tucker conditions. Linear programming problem: Standard form, Simplex method.

Unit-IV

Indirect methods: Elimination of constraints, Transformation techniques, and Penalty function method. Direct methods: Zoutendijk's method of feasible direction, Rosen's gradient Projection method

Unit-V

Specialized Optimisation techniques ¾ Dynamic programming, Geometric programming, Genetic Algorithms

Text Books

- Engineering Optimisation – Theory and Practice , S. S., New Age International, Rao
- Optimisation for Engineering Design – Algorithms and examples, Deb, K., Prentice Hall

Reference Books

- Optimum Structural Design, Kirsch U., McGraw Hill.
- Introduction to Optimum Design, Arora J S. McGraw Hil

Software or other Requirement

- ETAB

FUNDAMENTALS OF EARTHQUAKE ANALYSIS

Paper Code	**MEQ -202**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To impart the knowledge of structural dynamics (taught in the previous semester) for the analysis of structures for earthquake excitation.
- To understand the analysis of structures for different kinds of seismic excitation namely, time history records, FFT, power spectral density function and response spectrum.
- To acquaint the student with the frequency domain, time domain and non linear analyses including ductility.

Course Learning Outcome

- The students will learn available techniques for earthquake analysis of structures.
- The students will be able to use standard softwares for the seismic analysis of structures.
- Students will be able to model a structure for seismic analysis using right type of input and also, will be able to physically understand the results of the analysis.

Course Description

Unit-I

Seismology including seismic hazard analysis, various types of seismic inputs- time history, fourier spectrum, power spectral density function, design response spectrum, attenuation relationship

Unit-II

Analysis of structures for specified ground motion, time history analysis, frequency domain analysis, cases of multi supports excitation, modal analysis and mode acceleration approach

Unit-III

Spectral analysis of structures for random ground motion, case of single point excitation and multi point excitation, response analysis for partially correlated ground motion, modal spectral analysis

Unit-IV

Response spectrum method analysis for structures, single point excitation and multi points excitation, base shear approach, response spectrums provided in different codes and their critical appraisal

Unit-V

Inelastic response analysis of structure for earthquake, cases of single degree and multi degree freedom system, pushover analysis, concept of ductility, inelastic spectrum and ductility behaviour of tall buildings

Text Books

- A. K. Chopra, Structural Dynamics for Earthquake, Prentice Hall
- T. K. Datta, Seismic Analysis of Structures, John Wiley

Reference Books

- R.W. Clough and J. Penzien, Dynamics of Structures, McGraw Hill International

Software or other Requirement

- ETAB
- STAAD PRO

EARTHQUAKE RESISTANCE DESIGN OF STRUCTURES

Paper Code	**MEQ -203**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To impart the knowledge of required seismic input for earthquake resistant design, in particular response spectrum given in code.
- To acquaint the students with seismic design philosophy of structures (concrete, steel and masonry) consistent with code provisions and practices.
- To make the students aware of the seismic behavior of different structural components and accordingly use fundamentals of flexural and combined flexural cum shear design for the elements.

Course Learning Outcome

- The students will be able to effectively analyse and design the structures for seismic forces.
- Students will be able to understand ductile design and detailing of joints.
- Students would learn important code provisions for the seismic design of structures and would understand properly the basis of the code provisions.

Course Description

Unit-I

Modeling of Reinforced Concrete and Masonry buildings, response spectrum for with special emphasis on Code spectrum, Equivalent static Analysis, Seismic design philosophy, concept of strength, over strength, ductility and capacity design

Unit-II

Seismic Design of Building Components: Seismic resistant properties of reinforced concrete; Seismic behavior and design of linear reinforced concrete elements; Seismic behavior of planar reinforced concrete elements, code provisions

Unit-III

Seismic Provisions for Structural Steel Buildings: Materials, connections, joints and fasters;

Columns, ordinary, intermediate and special moment resisting frame; Con-centrically and eccentrically braced frames, code provisions

Unit-IV

Behaviour of masonry structures and earthquake resistant measures, Analysis for earthquake forces, role of floor and roof diaphragm; Concept and design of bands, bandages, splints and ties; Reinforced masonry; Vertical reinforcement at corners and jambs; Measures in random-rubble masonry; Confined masonry; Code provisions. Masonry Infills: Effect of masonry infills on seismic behaviour of framed buildings; Failure modes; Simulation of infills – FEM and equivalent strut; Safety of infills in in-plane action – shear, compression and buckling; Out-of-plane action, arching, code provisions, retrofitting of masonry building

Text Books

- Seismic Design of Reinforced Concrete and Masonry Buildings, Pauley, T. and Priestley, M.J.N, John-Wiley & Sons
- Elements of Earthquake Engg. and Structural Dynamics, Andre Filiatrault, Overseas Press India Pvt. Ltd.
- Earthquake Resistant Design of Structures, Pankaj Aggarwal and Manish Shrikhande, Prentice Hall of India Ltd

Reference Books

- Reinforced Masonry Design, Schneider, R.R. and Dickey, W.L, 3nd Ed., Prentice Hall
- Concrete Structure in earthquake regions, Edmund Booth, Design & Analysis" Longman Scientific & Technical

Software or other Requirement

- ETAB
- STAAD PRO

OFFSHORE STRUCTURES

Paper Code	**MEQ-204**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To have a sound knowledge of offshore structures.
- To study different wave theories for understanding sea characteristics.
- To study wind and wave forces in offshore environment.
- To acquire fundamental understanding of behavior of different kinds of offshore platforms under sea environment.

Course Learning Outcome

- After completion of the course, student will be able to have a sound knowledge of offshore structures.
- Understand different wave theories for understanding sea characteristics.
- Student will be able to understand to compute wind and wave forces in offshore environment.
- Student will understand fundamental behavior of different kinds of offshore platforms under sea environment.

Course Description

Unit-I

Introduction, Design of Fixed Offshore Structures, Examples of Fixed Offshore Structures, Analysis of Fixed Offshore Structures, Ocean Surface Waves, Wave Theories; Airy, Cnoidal and Stokes.

Unit-II

Environmental Loadings: Wind Speeds, Wind Forces, Wave Forces on Vertical Piles, Wave Forces on Arbitrarily Oriented Cylinders, Maximum Wave Force on an Offshore Structure, Joint Loads from Wave Forces, Buoyant Forces, Current Loadings, Additional Environmental Loadings.

Unit-III

Static Methods of Analysis, Design Environmental Conditions, Frame Analysis of Steel Offshore Structures, Bending Stress Amplification, Pressure induced stresses in steel structures, Design stress criteria for steel members.

Unit-IV

Analysis of Offshore Concrete Platforms, Pressure Induced Stresses in Concrete Structures; Effects of End Restraints, Spherical End Caps, Examination for Dynamic Effects, Dynamics of Structures, Lumped Description of Wave Forces.

Unit-V

Foundation Analysis: Soil Characteristics, Piles for Template Structures, Prediction of Axial Pile Capacity, Elastic response of Pile to Axial Loading, Footings for Offshore Structures, Bearing Capacity of Footings, Resistance of Footings to Sliding, Design of Footings subjected to General Loading Conditions.

Text Books

- Offshore Structural Engineering, Thomas H Dawson, Prentice-Hall, INC.
- Handbook of offshore engineering, S. K. Chakarbarti, Vol. 1&2, Elsevier Science

Reference Books

- Wave forces on offshore structures, Turgut Sarpkaya, Cambridge University Press.
- Dynamics of Offshore Structures, Minoo H. Patel, Butterworth & Co. Ltd.

Software or other Requirement

- SACS software for Fixed Platform's Design

RELIABILITY BASED DESIGN

Paper Code	**MEQ – 205**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To teach the fundamentals of reliability & design philosophy and significance of reliability in structural design
- To train students for various probabilistic and stochastic theorems as well as models applicable to reliability structures.
- To teach various reliability methods for feuding out reliability index and system reliability

Course Learning Outcome

- Students will have the understanding of fundamentals of reliability and importance of reliability in structural design
- Students will be conversant with various probabilistic and stochastic process/models applicable to structural reliability
- Students can assess the reliability index and system reliability

Course Description

Unit-I

Nature of Structural Design and Safety: Evolution of design codes; Hazards, risks and economy of structural design, Uncertainty Modeling: Probability theory, random variables, probability distributions, moments, extreme value statistics, utility and descriptive statistics; Fuzzy set theory

Unit-II

Bayesian Decision Theory: A priori and posteriori probability; Bayes strategy and computation, Statistical Inference: Model estimation, hypothesis testing, confidence intervals and significance testing

Unit-III

Stochastic Models for Material Strengths: Classic strength models - ideal brittle material, idea plastic material, fiber bundle; Fatigue - damage accumulation laws, cycle counting,

damage statistics; Bogdanoff's cumulative damage model. Stochastic Models for Loads: Gust wind loads, wave loads, earthquake loads, traffic load and live load modeling; Stochastic theory of load combinations

Unit-IV

Reliability Methods: Multiple safety factor formats; Characteristic values; Reliability index and system reliability; code calibrations

Text Books

- Ang , A.H., S. and Tang, W.H.. "Probability Concepts in Engineering Planning and Design, Vol. I & II., John Wiley & Sons
- Blockley , D.I.. "The Nature of Structural Design and Safety", Ellis Horwood
- Augusti, G., Baratta, A. and Casciati, F., "Probabilistic Methods in Structural Engineering, Chapman & Hall

Reference Books

- Chernoff, H. and Moses, L.E., "Elementary Decision Theory", Dover Publications
- Elishakoff, I.., "Probabilistic Theory of Structures", 2nd edition, Dover Publications

THIRD SEMESTER

ADVANCE REINFORCED CONCRETE DESIGN

Paper Code	**MEQ – 301**	**(Lectures-Tutorial-Practical)/Week (3-1-0)**
Credits	**4**	**Course Marks (Mid-End-Total) (40-60-100)**

Course Objectives

- To provide basic concepts, behaviour and design of various reinforced concrete structures
- To introduce IS code provisions of reinforced concrete design and reinforced detailing
- To introduce ductility requirement of design and detailing
- To introduce yield line analysis of slabs and pre-stressed concrete

Course Learning Outcome

- Students will have the understanding of basic concepts, behaviour and design of various reinforced concrete structures
- Students will be conversant with various IS code provisions of reinforced concrete design and reinforced detailing
- Students can assess the ductility requirement of design and detailing
- Students will be well aware about yield line analysis of slabs and prestressed concrete

Course Description

Unit-I

Introduction, Design Concepts, Design Methods, Characteristic strength and load; Reinforcement Concrete Materials; Cement, Aggregates, Water, Admixture, Pozzolana, Concrete, Plastic Concrete, Hardened Concrete, Concrete Mix Design; Design of reinforced concrete structural elements under–Flexure, Shear, Torsion, and Bond; Serviceability requirements

Unit-II

Design of slabs; One way slab, Two way slab, Flat slab and Waffle slab; Yield Line Analysis of slab

Unit-III

Design of Columns; Design of Column section under axial load, axial load and uni-axial

moment, axial load and bi-axial moments; Design of short and slender column elements;

Ductile reinforcement detailing of column
Unit-IV
Prestressed concrete and design of prestressed concrete structural elements

Text Books
• RCC Design, S.N. Sinha, Tata MacGraw Hill • Design of RCC, Pillai and Menon, Tata MacGraw Hill • Design of Prestressed Concrete, Krishna Raju, Tata MacGraw Hill

Reference Books
IS Codes: • IS 456: 2002 • SP:16 and SP:32 • IS 13920: 1993

Software or other Requirement
• ETAB • SAP • ANSYS

IMPORTANT CONTACT NUMBERS

Dean, Student's Welfare (DSW)	011-26980164
Proctor	0-9810439970
Dean, Faculty of Engg. & Tech.	011-26985831
Head, Deptt. of Civil Engineering	011-26985227
Training & Placement Officer	011-26989106
Professor Incharge Examination	011-26984127
Faculty of Engineering Library	011-26981717-2207

Department of Civil Engineering
Faculty of Engineering & Technology
Jamia Millia Islamia
New Delhi - 110025 (INDIA)
www.jmi.ac.in