Course Code: **19ESEC701** Course Title: **Numerical Methods and Programming**

L-T-P**: 4-0-1**	Credits: **5**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

Unit – I

1.Modelling, Computers and Error Analysis

Mathematical modelling, Analytical and numerical solutions, Computer programs, Algorithms, flow charts, Approximations, Round-off errors, Accuracy and precision, Machine epsilon **04 hrs**

2.Linear Algebra

Systems of linear algebraic equations, Uniqueness of solution, Ill-conditioned systems, Direct methods – Gauss elimination method, Gauss-Jordan method, LU decomposition by Crout method and Cholesky method; Iterative methods – Gauss Seidel method; Determinants and matrix inversion. **10 hrs**

3.Numerical Integration

Trapezoidal rule; Simpson's rules; Gaussian quadrature **06 hrs**

Unit – II

4.Solution of Nonlinear Equations

Bracketing methods – Bisection method, False position method; Secant method; Newton's method. **08 hrs**

5.Eigenvalue Problems

Eigenvalue problems, Eigenvectors, Jacobi method, Power method, Power methos with scaling, Power method with spectral shift, Inverse Power method. **06 hrs**

6.Interpolation and Curve Fitting

Interpolation, Lagrange's method, Newton's method, Polynomial methodCurve fitting, Least squares fit, Cubic splines. **06 hrs**

Unit – III

7.Solution of Ordinary Differential Equations

Euler's method; Second and fourth order Runge-Kutta methods; Systems of equations using Euler's and Runge-Kutta methods. **10 hrs**

Note

1. Emphasis must be on developing algorithms / flow charts and converting them into working programs. Computer implementation must be verified against solution obtained by built-in methods provided in programming language.
2. Programs can be written in Python/Scilab/MATLAB/Julia/C/C++ or any other programming language that the student finds suitable. In the class, Python will be used.
3. Pre-requisites: Working knowledge of Python/Scilab/MATLAB. This shall be done during an intensive hands-on workshop at the start of the semester.

References

1. Kiusalaas, J., *Applied Numerical Methods in Engineers with Python*, Cambridge University Press, 2005.
2. Gerald, C.F. and Wheatley, P.O., *Applied Numerical Analysis*, 6ed., Pearson Education, 1999.
3. Chapra, S.C. and Canale, R.P., *Numerical Methods for Engineers with Programming and Software Applications*, 3ed., Tata McGraw Hill, New Delhi, 1998.

Course Content

Course Code: **15ESEC801**		Course Title: **Advanced Material Science**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Unit – I

1. Structure of Concrete

Structure of aggregate phase & hydrated cement paste, mechanism of hydration, hydration products & micro structure, voids in cement paste, water in hydrated cement paste, properties of HCP, Transition zone in concrete. **08 hrs**

2.Special Conncretes

Fibre reinforced concrete, Carbon fibers, carbon nanotubes. Repair of Concrete structures, grouting shortcreting and guniting Epoxy resins, CFRP and GFRP sheets. **07 hrs**

Unit – II

1. Introduction to composite material

Introduction to materials, traditional materials, development, properties, strength of and mechanical properties of materials , introduction, definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites **05 hrs**

2. Fiber, matrices and their application

Fiber, matrices and their application - Different types of fibers and matrices. Polymer composites, metal composites and ceramic composites, Application of composites in different industries. **05 hrs**

6. An overview of Nanoscience & Nanotechnology

Historical background – nature, scope and content of the subject multidisciplinary aspects – industrial, economic and societal implications, Experimental techniques and Methods **06 hrs**

Introduction to Nanomaterials- Carbon Nanotubes , synthesis and purification – filling of nanotubes , mechanical and physical properties – applications

Unit – III

7. Introduction to nano-composite

Nano composite polymer matrix, nano composite ceramic matrix, nano composite metal matrix Applications in engineering, future scope of nano-composite, research. **05 hrs**

8.Safety and environmental aspects

Safety and environmental aspects of nano-materials, future challenge, cost optimization and fabrication process of nano composite materials **04 hrs**

Text Book:

1. Mehta, P. K., *Concrete: Microstructure, Properties, and Materials*, 4ed., McGraw-Hill Education: New York,, 2014.
2. A.M. Neville, *Properties of Concrete*, Longmans, 4th Edition, 1995
3. Hull D. and Clyne T.W., *Introduction to Composite Materials*, Cambridge University Press, 2ed, 1996.
4. Pradeep T., *NANO: The Essentials – Understanding Nanoscience and Nanotechnology*, 1ed., Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2017

References:

1. Sidney Mindess and J. Frances Young, *Concrete*, PH NJ, 1981.
2. IS: 10262 -2007 Code of Practice for Concrete Mix Design.
3. ACI 318-2005, Code of practice for reinforced concrete structures
4. Ventra M.,Evoy S., Heflin J.R., *Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology]*, Springer (2006).
5. Chawla K.K., *Composite Material : Science and Engineering*, 3ed., Springer, 2012.
6. Linda Williams & Wade Adams, *Nanotechnology Demystified*, McGraw-Hill Company Inc, New York, 2007.
7. Johns R.M., *Mechanics of Composite Materials*, 2ed., CRC Press, 2015.

Course Code: **18ESEP701**		Course Title: **Structural Simulation Laboratory**
L-T-P**: 0-0-1**	Credits: **1**	Contact Hrs: 2**hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **24hrs**		Exam Duration: **3 hrs**

List of experiments/jobs planned to meet the requirements of the course.

1. Introduction to ABAQUS modeling, material properties, meshing and element types.
2. Introduction to Loading, Boundary conditions and post processing.
3. Analysis of member forces in beams
4. Analysis of member forces in beams with surface interaction
5. Analysis of member forces and deflections in truss
6. Analysis of stress concentrations near the geometric imperfections
7. Analysis for member forces in portal frames.

Materials and Resources Required:

1. ABAQUS Benchmark manual 6.11.
2. ABAQUS release notes 6.13.
3. ABAQUS Example problem manual, Volume I (Statics and dynamics)
4. ABAQUS Example problem manual, Volume II (Other Applications and Analyses)
5. ABAQUS Verification manual

Course Title: Fire Resistance of Structures **Course Code:** 20ESEE701

L-T-P: 4-0-0 **Credits: 4** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40	**Examination Duration: 3 Hrs**

Unit I	
1.Introduction Overview, Fire Safety in Buildings, Fire Safety Objectives, Process of Fire Development, Fire Resistance, Controlling Fire Spread, Building Construction for Fire Safety.	**03 hrs**
2. Fire and Heat transfer Fuels, Combustion, Fire Initiation, t-squared fires, Heat Transfer.	**04 hrs**
3.Room Fires and Fire Severity Pre flashover, Flashover and Post flashover fires, Fire Severity and Fire Resistance, Equivalent Fire Severity.	**04 hrs**
4. Fire Resistance Introduction, Fire Resistance Tests, Listings, Fire Resistance by Calculation, Fire Resistance of Assemblies.	**03 hrs**
Unit II	
5. Design of Structures Exposed to Fire Overview of design of structures at normal temperature, Structural Design in Fire Condition, Material properties in fire, Design of individual members exposed to fire, Design of structural assemblies exposed to fire.	**10 hrs**
6. Design of Concrete Structures Exposed to Fire Behavior of concrete structures exposed to fire, Concrete and Reinforcing temperatures, Mechanical properties of concrete at elevated temperatures, Design of concrete members exposed to fire.	**08 hrs**
Unit III	
7. Design of Steel Structures Exposed to Fire Behavior of steel structures exposed to fire, Steel temperatures, Protection systems, Mechanical properties of steel at elevated temperatures, Design of steel members exposed to fire.	**08 hrs**

Text Books

1. Andrew H. Buchanan, *Structural Design for Fire Safety*, John Wiley and Sons, LTD, 2006.
2. John A. Purkiss, Long-Yuan Li, *Fire Safety Engineering Design of Structures*, CRC Press Taylor and Francis group Boca Raton, 2014.

Reference Books:

1. Yong Wang, Ian Burgess, Frantisek Wald, Martin Gillie, *Performance Based Fire Engineering of Structures*, CRC Press Taylor and Francis Group Boca Raton, 2013.
2. Naotake Noda, Richard B. Hetnarski, Yoshinobu Tanigawa, Thermal Stresses, Taylor and Francis group, New York, 2003.
3. EN 1992-1-1 Eurocode 2: Design of concrete structures - Part 1-2

Course Code: **20ESEC701** Course Title: **Earthquake Resistant Design of structures**
L-T-P**: 4-1-0** Credits: **5** Contact Hrs: **6 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **54 hrs** Exam Duration: **3 hrs**

Unit – I

1. Engineering Seismology **10 hrs**

Introduction, Reid's elastic rebound theory, Theory of plate tectonics; Seismic waves; Earthquake size – Intensity, Magnitude, Isoseismal map, Energy released in an earthquake; Local site effects; Seismicity of India; Classification of earthquakes.

2. Earthquake Load Specification

Response spectra, Design response spectrum; Equivalent static method; Response spectrum method; Time history analysis **12 hrs**

Unit – II

3.Design of Plan Asymmetric Buildings **10 hr**

Effect of plan asymmetry; Centre of mass, Centre of rigidity, Static eccentricity, dynamic eccentricity, accidental eccentricity; Design eccentricity; Design forces in asymmetric buildings; Seismic code analysis of buildings without locating centres of rigidity

4.Earthquake Resistant Design of Masonry Buildings **08 hrs**

Elastic properties of structural masonry; Lateral load analysis of masonry building

Unit – III

5.Design of Reinforced concrete buildings for earthquake resistance **08 hrs**

Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.

6. Techniques for Earthquake Resistance **04 hrs**

Base Isoloation, Passive and active control systems

References

1. Agarwal P. and Shrikhande M., *Earthquake Resistant Design of Structures*, Pentice-Hall of India Pvt. Ltd., New Delhi, 2011.
2. Chopra, A.K., *Dynamics of Structures*, 4ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.

3. Duggal, S.K., *Earthquake Resistant Design of Structures*, Oxford University Press, New Delhi, 2013.

IS Codes

1. IS:1893-2016 (Part 1), Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, 2016.
2. IS:13920-2016, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi, 2016.
3. IS:4326-2013, Earthquake Resistant Design and Construction of Buildings – Codeof Practice, Bureau of Indian Standards, New Delhi, 2013

Course Title: Structural Health Monitoring		Course Code: 20ESEE701
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 Hrs/ week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40		Examination Duration: 3 Hrs

Unit I	
1.Introduction Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Concepts, Various Measures, Structural Safety in Alteration.	**08 hrs**
2. Structural Audit Assessment of Health of Structure, Collapse and Investigation, Investigation Management, Assessment by NDT techniques, SHM Procedures.	**08 hrs**
Unit II	
4. Static Field Testing Types of Static Tests, Simulation and Loading Methods, Behavioral / Diagnostic tests - Proof tests, Sensor systems and hardware requirements, Static Response Measurement- strain gauges, LVDTs, dial gauges - case study	**08 hrs**
5. Dynamic Field Test Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Forced vibration method, Impact hammer and shaker testing, Hardware for Data Acquisition Systems, Network of sensors, Data compression techniques, Remote Structural Health Monitoring.	**08 hrs**
Unit III	
6. Introduction To Retrofitting and Repairs Of Structures Introduction to retrofitting of structures, Retrofitting of structural elements, Techniques, Material used for retrofitting, Case Studies, piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.	**08 hrs**

Text Books

1. Structural Health Monitoring Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes, John Wiley-ISTE, London, 2006.
2. Health Monitoring of Structural Materials and Components - Methods with Applications, Douglas E Adams, John Wiley & Sons, New York, 2007.

Reference Books:

1. "Structural Health Monitoring and Intelligent Infrastructure", Vol.-1, J.P. Ou, H. Li and Z. D. Duan, Taylor & Francis, London, 2006.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc., 2007