BITS-Pilani, Hyderabad Campus: Course Description

M.E. Civil – Structural Engineering

(For the most updated information, please refer to the latest Bulletin)

Year	First Semester			U	Second Semester			U
I	CE	G551	Dynamics of Structures	4	BITS	G540	Research Practice	4
	CE	G552	Advanced Structural Mechanics and Stability	4	CE	G615	Earthquake Engineering	4
							Elective	*
	CE	G617	Advanced Structural Analysis	4			Elective	*
	CE	G619	Finite Element Analysis	5				
				17				**14**
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				**16/ 20**

Core Courses:

- CE G551 Dynamics of Structures 4
- CE G552 Advanced Structural Mechanics and Stability 4
- CE G615 Earthquake Engineering 4
- CE G617 Advanced Structural Analysis 4
- CE G619 Finite Element Analysis 5

Elective Courses (any six):

- CE G511 Matrix Method in Civil Engineering 3 2 5
- CE G513 Advanced Computational Techniques 3 1 4
- CE G514 Structural Optimization 3 1 4
- CE G521 Topics in Structural Engineering 3 2 5
- CE G532 Advanced Soil Mechanics 3 1 4
- CE G533 Advanced Composite Materials for Structures 3 1 4
- CE G544 Fracture Mechanics of Concrete Structures 3 1 4
- CE G553 Theory of Plates and Shells 3 1 4
- CE G554 Advanced Structural Design 3 1 4
- CE G562 Advanced Concrete Technology 4
- CE G563 Stochastic Methods in Civil Engineering 3 1 4
- CE G564 Structural Health Assessment and Rehabilitation 3 1 4
- CE G610 Computer Aided Analysis and Design in Civil Engineering 3 2 5
- CE G611 Computer Aided Analysis and Design 3 2 5
- CE G612 Advanced Steel Structures 3 1 4
- CE G613 Advanced Concrete Structures 3 1 4
- CE G614 Prestressed Concrete Structures 3 1 4
- CE G616 Bridge Engineering 3 1 4
- CE G618 Design of Multi-storey Structures 3 1 4
- CE G620 Advanced Foundation Engineering 3 1 4
- CE G621 Fluid Dynamics 3 2 5

- CE G622 Soil-Structure Interaction 3 1 4
- CE G623 Ground Improvement Techniques 3 1 4
- CE G631 Selected Topics in Soil Mechanics and Geotechnical Engineering 3 1 4
- CE G632 Design of Foundation for Dynamic Loads 3 1 4
- CE G641 Theory of Elasticity and Plasticity 3 2 5

Core Courses:

CE G551 Dynamics of Structures [3 0 3]

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

CE G552 Advanced Structural Mechanics and Stability [3 1 4]

Analysis of stress and strain in three-dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degrees of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

CE G615 Earthquake Engineering [3 1 4]

Single and multi-degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

CE G617 Advanced Structural Analysis [3 1 4]

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three-dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

CE G619 Finite Element Analysis [3 2 5]

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

Electives (any six):

CE G511 Matrix Methods in Civil Engineering [3 2 5]

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

CE G513 Advanced Computational Techniques [3 1 4]

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

CE G514 Structural Optimization [3 1 4]

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

CE G521 Topics in Structural Engineering [3 2 5]

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

CE G532 Advanced Soil Mechanics [3 1 4]

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi-infinite elastic soils; vibration problems.

CE G533 Advanced Composite Materials for Structures [3 1 4]

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

CE G544 Fracture Mechanics of Concrete Structures [3 1 4]

Types of failure, Types of fracture, Modes of fracture, Fracture criteria, Energy release rate, Stress intensity factor (SIF), SIF of more complex cases, , Elastic plastic analysis through J-integral, Crack tip opening displacement, Test methods, Fatigue failure, Fracture mechanics of concrete: Need for fracture in concrete, Linear Elastic fracture models, Elasto-plastic fracture models, Nonlinear fracture models, RILEM fracture energy, softening of concrete, fracture process zone, size effect, Interface fracture, Fracture behaviour of special concretes, Numerical analysis.

CE G553 Theory of Plates and Shells [3 1 4]

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

CE G554 Advanced Structural Design [3 1 4]

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

CE G562 Advanced Concrete Technology [4]

Components of concrete; chemical properties of cement & cementitious paste; heat of hydration; microstructure of cementitious paste; properties of aggregates; chemistry of mineral admixtures; chemistry of chemical admixtures; characterization of powdered and solid block concrete; effect of concrete composition on properties of fresh concrete; rheology of concrete; effect of concrete composition on properties of hardened concrete; shrinkage and creep; correlation between micro- and specimen level properties, interfacial transition zone (ITZ); durability of concrete; prediction of concrete service life; techniques for non-destructive evaluations (NDE) of concrete; green concrete; concrete with alkali activated binders (AAB); difference between alkali –activated binders and blended cements.

CE G563 Stochastic Methods in Civil Engineering [3 1 4]

Uncertainty, Discrete and Continuous distributions, Hypothesis testing, Classification and characteristics of time series, Autocorrelation analysis, Multivariate data analysis by logistic regression, discriminant analysis, cluster analysis, factor analysis, queuing theory, Reliability analysis, Statistical quality control, Introduction to univariate and multivariate stochastic models, markov chain and their properties, introduction to Transition probability, case studies.

CE G564 Structural Health Assessment and Rehabilitation [3 1 4]

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and extrinsic causes an stage of Distress, Condition survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures, Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

CE G610 Computer Aided Analysis and Design in Civil Engineering [3 2 5]

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of pre-processor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

CE G611 Computer Aided Analysis and Design [3 2 5]

The course aims at developing complete self-reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CE G612 Advanced steel Structures [3 1 4]

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

CE G613 Advanced Concrete Structures [3 1 4]

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

CE G614 Prestressed Concrete Structures [3 1 4]

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

CE G616 Bridge Engineering [3 1 4]

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

CE G618 Design of Multi-Storey Structures [3 1 4]

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

CE G620 Advanced Foundation Engineering [3 1 4]

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

CE G621 Fluid Dynamics [3 2 5]

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory; flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CE G622 Soil-Structure-Interaction [3 1 4]

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

CE G623 Ground Improvement Techniques [3 1 4]

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electroosmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

CE G631 Selected Topics in Soil Mechanics and Geotechnical Engineering [3 1 4]

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends

CE G632 Design of Foundations for Dynamic Loads [3 1 4]

Evaluation and interpretation of geotechnical reports, selecting foundation design parameters from laboratory and field tests, Selection of foundation, Analysis and design of strip, isolated & combined footing, circular and ring foundation, Design of raft foundation using conventional rigid method, Coefficient of subgrade reaction, Winkler model for footings and mat on elastic foundations, Proportioning and structural design of footings subjected to combined vertical, moment and horizontal loads, Seismic design of shallow foundations, ductile detailing, Analysis and design of different type of pile foundations, piles subjected lateral load, moment and uplift, piles subjected to dynamic loads, design of pile group and pile cap, Seismic design of pile foundations and ductile detailing, Analysis and design of retaining walls, reinforced earth wall design, seismic design of retaining structure, Analysis and design of machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbo-generator, Computing static and dynamic stiffness of foundations, soil-structure interaction, Optimization and computer aided design of foundation, BIS, IRC, ACI, ASCE, AASTHO and Euro code provisions on structural and earthquake resistant design of foundations.

CE G641 Theory of Elasticity and Plasticity [3 2 5]

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.