

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE401	DESIGN OF STEEL STRUCTURES	4-0-0-4	2016

Prerequisite : CE202 Structural Analysis II

Course objectives:

- To introduce the limit state design of steel structural components subjected to bending, compression and tensile loads including the connections
- To enable design of structural components using timber

Syllabus:

Steel and steel structures – bolted and welded connections- tension members – compression members – beams – roof trusses – purlins – timber structures – columns- composite beams

Expected Outcomes:

The students will be able to

- design bolted and welded connections
- design tension members and beams using the IS specifications
- design columns under axial loads using IS specifications
- design beams and plate girders
- assess loads on truss and design purlins
- design structural components using timber.

Text Books:

1. L S Jayagopal, D Tensing., Design of steel structures, S Chand & Company, 2015
2. S K Duggal., Limit State design of steel structures, Tata McGraw Hill, 2010
3. Subramanian N, Design of steel Structures, Oxford University Press, 2011

References :

1. P. Dayaratnam., Design of Steel Structures ,Wheeler Publishing, 2003
2. Punmia B. C., Jain A. K. and Jain A. K., Design of Steel Structures, Laxmi Publications (P) Ltd, 2017
3. Raghupathi, Steel Structures, Tata McGraw Hill, 2006
4. Ramchandra S and Virendra Gehlot, Design of Steel Structures Vol. II, Standard Book House, 2007
5. V L Shah & Veena Gore, Limit State Design of steel Structures , Structures Publications, 2009
6. William T Segui., Steel Design , Cenage Learning, 6e, 2017
7. IS 800 – 2007, Code of practice for Structural steel design, BIS

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to steel and steel structures, properties of steel, structural steel sections. Introduction to design: Design loads and load combinations, limit state design concepts. Connections bolted and welded (direct loads)	9	15

II	Tension members-Types of sections – net area- design of tension members- concept of shear lag-use of lug angle-connections in tension members	9	15
FIRST INTERNAL EXAMINATION			
III	Compression members- design of struts- solid and built up columns for axial loads-- design of lacings and battens-column bases- slab base – gusseted base	10	15
IV	Design of beams- laterally restrained and unrestrained – simple and compound beams- plate girders subjected to uniformly distributed loads – design of stiffeners.	9	15
SECOND INTERNAL EXAMINATION			
V	Design of roof trusses- types-design loads and load combinations- assessment of wind loads- design of purlins. Moment resistant/Eccentric connections (in plane and out of plane)	10	20
VI	Design of timber structures: types of timber - classification - allowable stresses-design of beams-flexure, shear, bearing and deflection considerations-Design of columns. Design of composite beam sections with timber and steel.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2 .Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE403	STRUCTURAL ANALYSIS - III	3-0-0-3	2016

Prerequisite : CE303 Structural Analysis - II

Course objectives:

- To enable the students to have a comprehensive idea of matrix structural analysis with emphasis on the relative advantages of the flexibility method and the stiffness method
- To enable the students to visualize structural dynamics problems with a proper blend of structural analysis and vibration theory

Syllabus :

Approximate Methods of Analysis of Multistoried Frames, Matrix analysis of structures, Flexibility method, Stiffness method, Introduction to direct stiffness method, Structural dynamics

Expected Outcomes:

The students will be able to

- analyse structures using approximate method
- analyse trusses, continuous beams and rigid frames using flexibility method
- analyse trusses, continuous beams and rigid frames by stiffness method
- conceive Finite element procedures by direct stiffness method
- use the basics of structural dynamics and analyse the response of SDOF systems

Text Books :

1. G S Pandit and S P Gupta, Structural analysis a Matrix approach, McGraw Hill Education (India), 2e, 2008
2. Gere, J.M. and William Weaver, Matrix Analysis of framed structures, CBS Publishers, 1990
3. Kenneth M Leet, Chia Ming Uang, Anne M Gilbert, Fundamentals of structural analysis, Tata McGraw Hill Pvt Ltd., 4e, 2010
4. Reddy C.S., Basic structural analysis, Tata McGraw Hill, third edition, 3e, 2012

References :

1. Anil. K. Chopra, Dynamics of structures, Pearson Education/ Prentice Hall India, 5e, 2016
2. Clough R.W. and Penzein, J., Dynamics of structures, Tata McGraw Hill, 1995
3. Madhujith Mukhopadhyay and Abdul Hamid Sheikh, Matrix and Finite Element Analysis of Structures, Ane Books India, 2009
4. Mario Paz , Structural Dynamics: Theory & Computation, 2e, CBS Publishers, 2004
5. Rajasekharan. S. and Sankarasubramanian G., Computational structural Mechanics, PHI, 2009
6. Wang C.K., Matrix method of structural analysis, International Text book company, 1970

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Approximate Methods of Analysis of Multistoried Frames: Analysis for vertical loads-substitute frames-loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns- wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis.	6	15

II	Matrix analysis of structures: static and kinematic indeterminacy-force and displacement method of analysis-definition of flexibility and stiffness influence coefficients Concepts of physical approach	6	15
FIRST INTERNAL EXAMINATION			
III	Flexibility method: flexibility matrices for truss and frame elements-load transformation matrix-development of total flexibility matrix of the structure-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects	7	15
IV	Stiffness method: Development of stiffness matrices by physical approach-stiffness matrices for truss and frame elements-displacement transformation matrix-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects	7	15
SECOND INTERNAL EXAMINATION			
V	Introduction to direct stiffness method-Rotation of axes in two dimensions, stiffness matrix of elements in global co-ordinates from element co-ordinates- assembly of load vector and stiffness matrix, solution of two span continuous beam-single bay single storey portal frame.	8	20
VI	Structural dynamics-introduction-degrees of freedom-single degree of freedom subjected to harmonic load -linear systems- equation of motion, D'Alembert's principle-damping- free response of damped and undamped systems- logarithmic decrement- transient and steady state responses, Dynamic magnification factor – Vibration isolation –Concept of two degree of freedom systems (No derivation and numerical problems)	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI: 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE405	ENVIRONMENTAL ENGINEERING- I	3-0-0-3	2016

Pre-requisites: CE203 Fluid Mechanics -I

Course objectives:

- To study the significance of water resources and the factors affecting the quality and quantity of water
- To study the various types of treatment techniques adopted for a public water supply system

Syllabus :

Water sources, demand, factors, Quantity estimation, Population forecasting, Quality of water. Water treatment- Physical methods, Chemical methods. Design of sedimentation tank, flocculator, clariflocculator, filters, Membrane treatment techniques. Disinfection- methods. Distribution of water, Pumps, Hardy Cross method of analysis

Expected Outcomes:

The students will

- become aware of the various pollutants affecting water quality
- know about the different treatment units available in a water treatment plant and their design procedures

Text Books:

1. B.C Punmia, “Water Supply Engineering”, Laxmi Publications Pvt. Ltd., 2016
2. G S Birdie, Water Supply and Engineering, Dhanapat Rai Publishing Company, 2014
3. P.N. Modi, “Water Supply Engineering”, Standard Book House, NewDelhi
4. Peavy H S, Rowe, D.R. Tchobanaglou “Environmental Engineering” Mc GrawHill Education, 1984
5. S.K.Garg, “Water Supply Engineering”, Khanna Publishers. 2010

References

1. K N Dugal, Elements of Environmental Engineering, S Chand and Company Pvt Ltd, 2007
2. Mackenzie L Davis, Introduction to Environmental Engineering, McGrawhill Education (India), 2012
3. Metcalf & Eddy , “Waste Water Engineering”, Tata Mc Grawhill Publishing Co Ltd, 2003
4. P Venugopala Rao, Environmental Engineering, PHI Learning Pvt Ltd, 2002
5. Subhash Verma, Varinder Kanwar, Siby John, Water supply Engineering, Vikash Publishing, 2015

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction of environment- sources of water supply-Water demand, quantification of water demand through population forecasting – Factors affecting consumption-Fluctuations in demand	7	15

II	Types of intakes-Conveyors, pumps and location of pumping station-Quality of water - Drinking water standards - Physical, chemical and biological analysis.	6	15
FIRST INTERNAL EXAMINATION			
III	Treatment of water-Theory and principles of Sedimentation tanks-Stoke's law-Types of settling (Type I & Type II only)-Coagulation-Mixing-Flocculation, Design of Sedimentation tanks (circular and rectangular)-Clariflocculators	7	15
IV	Filtration-Types of filters- Working and Design of Rapid and Slow sand filters. Loss of head in filters, Pressure filters	7	15
SECOND INTERNAL EXAMINATION			
V	Disinfection of water - Methods, Chlorination-Types, Factors affecting - Chlorine demands. Miscellaneous treatment-Ion exchange, Lime-soda process, Electro dialysis - Colour, Taste and Odour removal-Adsorption-Aeration-Fluoridation-Defluoridation	7	20
VI	Lay out of water distribution network-Methods of distribution-Hardy cross method-Equivalent pipe method-Pipe appurtenances.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note :

1. Each part should have at least one question from each module
2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE407	TRANSPORTATION ENGINEERING - II	3-0-0-3	2016

Prerequisite : CE308 Transportation Engg.-I

Course Objectives:

- To set a solid and firm foundation in Railway engineering, including the history development, modern trends, maintenance, geometric design and safety of railways.
- To introduce dock, harbour and tunneling

Syllabus :

Introduction to railways in India and its evolution, modern technologies, geometric design of tracks, railway operation control, maintenance and an introduction to the railway accidents. Alignment, surveying, driving, ventilation and drainage of tunnels and types of harbours and docks.

Course Outcome:

- This course will enable students to gain knowledge in railway and water transportation.

Text Books:

1. Mundrey J. S, Railway Track Engineering, Tata McGraw Hill, 2009
2. Rangawala, S.C. , Railway Engineering, Charotor Publishing House
3. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996
4. Srinivasan,R., Harbour, Dock & Tunnel Engineering, Charotor Publishing House, 28e, 2016

References:

1. Bindra, S.P., A course in Docks and Harbour Engineering, Dhanpat Rai& Sons
2. Chandra, S. and Agarwal, M.M. ,Railway Engineering, Oxford University Press, New Delhi, 2008
3. Saxena, S. C and Arora, S. P, Railway Engineering, Dhanpat Rai& Sons, 7e, 2010
4. Subhash C. Saxena, Railway Engineering, Dhanpat Rai& Sons

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to Railways in India: Role of Indian Railways in National Development – Railways for Urban Transportation – Modern developments- LRT & MRTS, tube railways, high speed tracks. Alignment- basic requirements and factors affecting selection, Component parts of a railway track - requirements and functions - Typical cross-section	7	15
II	Permanent Way: Components and their Functions: Rails - Types of Rails, Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps and kinks . Sleepers – Functions, Materials, Density , Ballast less Tracks. Geometric design of railway track: Horizontal curves, radius – super	7	15

	elevation -cant deficiency - transition curves - gradients - different types - Compensation of gradients.		
FIRST INTERNAL EXAMINATION			
III	Railway operation and control: Points and Crossings – Design features of a turnout – Details of station yards and marshalling yards – Signaling, interlocking of signals and points - Principles of track circuiting - Control systems of train movements – ATC, CTC – track circuiting	6	15
IV	Maintenance:- Introduction to track maintenance, Items of track maintenance, packing and over hauling, screening Railway accidents: Human and system contribution to catastrophic accidents, Human Factors in Transport Safety.	6	15
SECOND INTERNAL EXAMINATION			
V	Tunnel Engineering: Tunnel - sections - classification - tunnel surveying -alignment, transferring centre, grade into tunnel – tunnel driving procedure - shield method of tunneling, compressed air method, tunnel boring machine, Tunnel lining, ventilation - lighting and drainage of tunnels.	8	20
VI	Harbours – classification, features, requirements, winds and waves in the location and design of harbours. Break waters - necessity and functions, classification, alignment, design principles, forces acting on break water – construction, general study of quays, piers, wharves, jetties, transit sheds and warehouses - navigational aids - light houses, signals - types - Moorings Docks – Functions and types - dry docks, wet docks – form and arrangement of basins and docks	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE409	QUANTITY SURVEYING AND VALUATION	3-0-0-3	2016

Pre-requisites: CE334 Computer Aided Civil Engg. Lab

Course objectives:

- To have an awareness regarding specifications, analysis of rates, valuation etc. in connection with construction
- To prepare detailed estimates, bar bending schedules of various items of work

Syllabus :

Specifications- Analysis of rates- CPWD data book and schedule of rates- Detailed specification, preparation of data and analysis of rates for various items of work- Quantity Surveying- Types of Estimate - Valuation- Methods of valuation-Depreciation- Fixation of rent- Detailed estimate including quantities, abstract and preparation of various items of works, Preparation of bar bending schedules for various RCC works

Expected Outcomes:

The students will be able to

- work out the quantities of materials and labour required for different types of civil works
- prepare schedule of rates for various items of work

Text Books

1. B N Dutta, Estimating and costing in Civil Engineering, USB publishers and distributors Ltd. New Delhi
2. D D Kohli, RC Kohli, A textbook of Estimating and costing, S Chand Publishing, 2011
3. Dr. S. Seetharaman, M. Chinnasamy, Estimation and Quantity Surveying, Anuradha Publications , Chennai.

References:

1. BS Patil, Civil Engineering contracts and estimates, Universities press
2. V N Vazirani & S P Chandola, Civil engineering Estimating and Costing, Khanna Publishers.
3. IS 1200-1968; Methods of measurement of Building & Civil Engineering works.
4. CPWD data book and schedule of rates.

Note:

For analysis of rate and cost estimation, unit rate and labour requirement should be given along with the questions in the question paper.. No other charts, tables, codes are permitted in the Examination Hall. If necessary, relevant data shall be given along with the question paper.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	General Introduction- Quantity Surveying- Basic principles-Types of Estimates - Specifications- purposes and basic principles-general specifications - Detailed specifications-Method of measurement of various items of work. Analysis of rates- Introduction to the use of CPWD data book and schedule of rates- conveyance and conveyance statement -	6	10

	Miscellaneous charges.		
II	Preparation of data and analysis of rates for various items of work connected with building construction and other civil engineering structures with reference to Indian Standard Specification.	6	10
FIRST INTERNAL EXAMINATION			
III	Detailed estimate including quantities, abstract and preparation of various items of works- buildings- centerline method and long wall short wall method- sanitary and water supply works- soak pits, septic tanks, overhead tanks, culverts, Retaining walls, road construction. Bar-bending schedule-preparation of bar-bending schedule for RCC works connected with building construction, culverts and minor irrigation works.	18	50
SECOND INTERNAL EXAMINATION			
IV	Valuation - Explanation of terms, types of values, sinking fund, years purchase, Depreciation - Straight line method, constant percentage method, S.F method .Obsolescence. Valuation of real properties-rental method, profit based method, depreciation method. Valuation of landed properties -belting method, development method, hypothecated building scheme method. Rent calculation. Lease and Lease hold property	12	30
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks: 100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 10 marks each

Part B - Module III : 2 questions out of 3 questions carrying 25 marks each

Part C - Module IV : 2 questions out of 3 questions carrying 15 marks each

Note : 1. Part A should have at least one question from each module

2. Part B three full questions carrying 25 marks on building estimate, preparation of bending schedule, or estimation of any other structure.

3. Part A and C each question can have a maximum of 2 subdivisions (a, b)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE469	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To know the various types of environmental pollution
- To make aware the impact due to various types of pollutants and their assessment technique

Syllabus : Pollution, Types. Air pollution-sources, effects, types of pollutants. Water pollution, characteristics of water pollutants, Solid wastes, sources, types, soil pollution, pesticide pollution. Noise pollution, Impacts, positive and negative Environmental impact assessment, steps of doing EIA, methodology adopted, EIA procedure in India, Case studies.

Expected Outcomes:

- The students will gain basic knowledge of various pollution sources and their impacts

Text Books / References:

1. A K Srivastava, Environment impact Assessment, APH Publishing, 2014
2. John Glasson, Riki Therivel & S Andrew Chadwick “Introduction to EIA” University College London Press Limited, 2011
3. Larry W Canter, “Environmental Impact Assessment”, McGraw Hill Inc. , New York, 1995.
4. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification
5. Rau G J and Wooten C.D “EIA Analysis Hand Book” Mc Graw Hill
6. Robert A Corbett “Standard Handbook of Environmental Engineering” McGraw Hill, 1999.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	INTRODUCTION: Classification of Pollution and Pollutants, – Evolution of EIA (Global and Indian Scenario)- Elements of EIA — Screening – Scoping - Public Consultation - Environmental Clearance process in India - Key Elements in 2006 EIA(Govt. of India) Notification	6	15
II	AIR POLLUTION: Primary and Secondary Types of Pollutants, sulfur dioxide- nitrogen dioxide, carbon monoxide, WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Impact of pollutants	6	15
FIRST INTERNAL EXAMINATION			
III	SOLID WASTE: Classification and sources of Solid Waste, Characteristics, effects, e waste, : Effects of urbanization on land degradation, pesticide pollution NOISE POLLUTION: Sources of Noise, Effects of Noise,	7	15

	Control measures		
IV	Impacts of pollutants, types, scale of impact-Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation , Impact of development on vegetation and wild life	7	15,
SECOND INTERNAL EXAMINATION			
V	Socio-economic impacts - Impact assessment Methodologies- Overlays, Checklist, Matrices, Fault Tree Analysis, Event Tree Analysis- Role of an Environmental Engineer- Public Participation	8	20
VI	Standards for Water, Air and Noise Quality - Environmental Management Plan- EIA- Case studies of EIA	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE473	ADVANCED COMPUTATIONAL TECHNIQUES AND OPTIMIZATION	3-0-0-3	2016
Prerequisite : CE306 Computer Programming and Computational Techniques			
Course objectives: <ul style="list-style-type: none"> To introduce different numerical solutions and importance of optimization To impart ability to apply mathematics and optimizing techniques for finding solutions to real time problems. 			
Syllabus : <p>Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Elimination and factorization methods- Gauss Seidel iteration. Eigen Value problems- power method. General Optimisation procedures - and features of mathematical programming as applicable to Civil engineering problems. Unconstrained and constrained optimization problems - Formulation of objective function and constraints. Lagrangian interpolation- Quadratic and Cubic splines (Problems on quadratic splines only)- Data smoothing by least squares criterion- Non-polynomial models like exponential model and power equation- Multiple linear regression. Numerical integration- Newton – Cotes open quadrature- Linear Programming - Simplex method standard form - Simplex algorithm - Two phase solution by simplex method - Duality of linear programming Formulation of geometric programming. Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Runge- kutta method- Ordinary differential equations of the boundary value type- Finite difference solution- Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations Non- Linear Programming problems – one dimensional minimisation. Unconstrained optimization Techniques Direct search method. Random search Univariate pattern search. Descent methods.</p>			
Course Outcomes: <p>The students will be able to:</p> <ol style="list-style-type: none"> Find different numerical solutions of complicated problems Determine solutions of real time problems applying numerical methods in mathematics Understand the importance of optimization and apply optimization techniques in real time problems 			
Text Books / References: <ol style="list-style-type: none"> Grewal B.S. “Numerical Methods in Engineering and Science” Khanna Publishers. Chapra S.C. and Canale R.P. “Numerical Methods for Engineers” Mc Graw Hill 2006. Smith G.D. “Numerical solutions for Differential Equations” Mc Graw Hill Ketter and Prawel “Modern Methods for Engineering Computations” Mc Graw Hill Rajasekharan S. “Numerical Methods in Science and Engineering” S Chand & company 2003. Rajasekharan S. “Numerical Methods for Initial and Boundary value problems,” Khanna publishers 1989. Terrence .J.Akai “Applied Numerical Methods for Engineers”, Wiley publishers 1994. R.L. Fox , Optimisation methods in Engineering Design, Addison Wesley S.S. Rao , Optimisation Theory and applications , Wiley Eastern. Belegundu., Optimisation concepts and Applications Engineering, 			

11. Andrew B Templeman, Civil Engineering Systems

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to numerical methods- errors in numerical methods- Systems of linear algebraic equations- Elimination and factorization methods- Gauss Seidel iteration. Eigen Value problems- power method.	7	15
II	General Optimisation procedures - and features of mathematical programming as applicable to Civil engineering problems. Unconstrained and constrained optimization problems - Formulation of objective function and constraints.	6	15
FIRST INTERNAL EXAMINATION			
III	Lagrangian interpolation- Quadratic and Cubic splines (Problems on quadratic splines only)- Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation- Multiple linear regression. Numerical integration- Newton – Cotes open quadrature	7	15
IV	Linear Programming - Simplex method standard form - Simplex algorithm - Two phase solution by simplex method - Duality of linear programming Formulation of geometric programming	6	15
SECOND INTERNAL EXAMINATION			
V	Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Runge- kutta method- Ordinary differential equations of the boundary value type- Finite difference solution- Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations	7	20
VI	Non- Linear Programming problems – one dimensional minimisation. Unconstrained optimization Techniques Direct search method. Random search Univariate pattern search. Descent methods	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)