

SCCA9501	INDUSTRY 4.0	L	T	P	Credits	Total Marks
		2	0	2	2	100

UNIT1 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING**9 Hrs.**

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system based telemedicine, diagnosis and therapeutics through real time biosensors. Bionanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 2 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT**9 Hrs.**

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway- Vertical farming - Intellectual Property rights: Case studies

UNIT 3 SMART MANUFACTURING**9 Hrs.**

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self propelled vehicles, e mobility, Green fuels, drones – unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies- Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 4 SMART WORLD**9 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, Intellectual Property Rights- Case Studies.

UNIT 5 CYBER PHYSICAL SYSTEMS**9 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Deep Learning, Gamification, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : Case Studies.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. William D. Callister, "Materials Science and Engineering, An Introduction", John Willey and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice", Prentice Hall India Pvt. Ltd, 2006.
3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, 2019.
4. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
5. Oliver Grunow, "Smart Factory and Industry 4.0. The current state of Application Technologies", Studylab Publications, 2016.
6. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.
7. Sang C. Suh, U. John Tanik, John N. Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013.

PROGRAMME: M.E.
STRUCTURAL ENGINEERING
CURRICULUM

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA5101	Advanced Mathematics	3	0	0	3	50	50	1
2	Theory	SCIA5101	Advanced Reinforced Concrete Structures	3	0	0	3	50	50	2
3	Theory	SCIA5102	Theory of Elasticity and Plasticity	3	0	0	3	50	50	3
4	Theory	SCIA5103	Matrix Method of Structural Analysis	3	0	0	3	50	50	4
5	Theory	SCIA5104	Experimental Stress Analysis and Techniques	3	0	0	3	50	50	5
6	Practical	SCIA6101	Structural Analysis Lab - I	0	0	4	2	50	50	6
7	Practical	SCIASEM1	Seminar	0	0	2	1	50		-
Total Credits for Semester 1 - 18										
Total Marks for Semester 1 - 650										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SCIA5201	Finite Element Analysis	3	0	0	3	50	50	7
2	Theory	SCIA5202	Structural Dynamics	3	0	0	3	50	50	8
3	Theory	SCIA5203	Advanced Design of Steel Structures	3	0	0	3	50	50	9
4	Theory	SCCA9501	Industry 4.0	2	0	0	2	50	50	10
5	Theory		Elective - 1	3	0	0	3	50	50	-
6	Theory		Elective - 2	3	0	0	3	50	50	-
7	Practical	SCIA6201	Structural Analysis Lab – II	0	0	4	2	50	50	11
Total Credits for Semester 2 - 19										
Total Marks for Semester 2 - 700										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS,

CAE – CONTINUOUS ASSESSMENT EXAMINATION

ESE – END SEMESTER EXAMINATION

SEMESTER 3										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SCIA5301	Seismic Design of Structures	3	0	0	3	50	50	12
2	Theory		Elective - 4	3	0	0	3	50	50	-
3	Theory		Elective - 5	3	0	0	3	50	50	-
4	Theory		Elective - 6	3	0	0	3	50	50	-
5	Practical	SCI A6301	Structural Engineering Lab	0	0	4	2	50	50	13
6	Practical	SCIASEM2	Seminar	0	0	2	1	50		-
7	Project	S38APROJ1	Project Work (Phase - 1)	0	0	6	3	50	50	-
Total Credits for Semester 3 - 18										
Total Marks for Semester 3 - 650										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Project	S38APROJ2	Project Work (Phase – II)	0	0	30	15	50	50	-
Total Credits for Semester 4 - 15										
Total Marks for Semester 4 - 100										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS,
 CAE – CONTINUOUS ASSESSMENT EXAMINATION,
 ESE – END SEMESTER EXAMINATION

PROFESSIONAL ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SCIA7001	Advanced Concrete Technology	3	0	0	3	50	50	14
2	SCIA7002	Mechanics of Composite Materials	3	0	0	3	50	50	15
3	SCIA7003	Maintenance and Rehabilitation of Structures	3	0	0	3	50	50	16
4	SCIA7004	Design of Bridges	3	0	0	3	50	50	17
5	SCIA7005	Theory of Plates and Shells	3	0	0	3	50	50	18
6	SCIA7006	Offshore structures	3	0	0	3	50	50	19
7	SCIA7007	Design of Sub Structures	3	0	0	3	50	50	20
8	SCIA7008	Design of Steel Concrete Composite Structures	3	0	0	3	50	50	21
9	SCIA7009	Prestressed Concrete Structures	3	0	0	3	50	50	22
10	SCIA7010	Design of Tall Buildings	3	0	0	3	50	50	23
11	SCIA7011	Stability of Structures	3	0	0	3	50	50	24
12	SCIA7012	Nonlinear Analysis of Structures	3	0	0	3	50	50	25
13	SCIA7013	Structural Optimization	3	0	0	3	50	50	26
14	SCIA7014	Industrial Structures	3	0	0	3	50	50	27
15	SCIA7015	Energy Efficient Structures	3	0	0	3	50	50	28
16	SCIA7016	Environmental Engineering Structures	3	0	0	3	50	50	29
17	SCIA7017	Prefabricated Structures	3	0	0	3	50	50	30
18	SCIA7018	Design of Structures for Dynamic Loads	3	0	0	3	50	50	31

Semester	Theory courses (including elective courses)			Practical Courses (including PT and project)		
	Total no.	Total Credits	Total Marks	Total no.	Total Credits	Total Marks
1	5	15	500	2	3	150
2	6	17	600	1	2	100
3	4	12	400	3	6	250
4	0	0	0	1	15	100
Over all Total	15	44	1500	8	26	600

Overall total credits for M.E Structural Engineering	70
Overall total marks for M.E Structural Engineering	2100

SCIA7012	NON LINEAR ANALYSIS OF STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the concept of nonlinear behaviour and analysis of elements and simple structures.

UNIT 1 INTRODUCTION**9 Hrs.**

Introduction- Types of Non-Linearities-Non-linear Governing equations for Beams-Geometrically non linear beams for various supports- vibrations of Beams with various boundary conditions-forced vibrations of Beams-Post buckling of Column- Behaviour of Beams with Material Non linearity.

UNIT 2 RECTANGULAR PLATES**9 Hrs.**

Governing Non linear equations of Plates-Boundary conditions –Large deflections of Rectangular plates- Free and forced vibration of Rectangular plates- Free and forced vibration of Non Rectangular plates-Large deflections of Rectangular, Non Rectangular plates- Post buckling of Plates- Effects of Transverse Shear Deformation.

UNIT 3 SHELLS**9 Hrs.**

Non linear analysis of Shells-Circular Cylindrical shells-Shallow Spherical shells-Non Circular Cylindrical shells-Forced Non-linear vibration of shells-Post buckling of shells.

UNIT 4 TRUSSES AND FRAMES**9 Hrs.**

Non linear analysis of curved beams-trusses-frames- Three Dimensional Mechanism-Large and small deformation and large angle of rotation- classical linear theory- Non linear material properties – finite element method- stiffened structures.

UNIT 5 COMPOSITE MATERIAL**9 Hrs.**

Non linear analysis of composite materials- composite beams- non linear vibrations- Post buckling behavior- composite plates governing equation-laminated plates cylindrical bending- laminated plates large amplitude vibration.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. Fertis, D.G., "Nonlinear Mechanics", CRC Press, 1999.
2. Reddy.J.N., "Non linear Finite Element Analysis", Oxford University Press, 2008.
3. Sathyamoorthy M., "Nonlinear Analysis of Structures", CRC Press, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SCI5610	STRUCTURAL OPTIMIZATION	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

To study the optimization methodologies applied to structural engineering.

UNIT 1 BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 12 Hrs.

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space- Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Kuhn - Tucker Criteria).

UNIT 2 LINEAR AND NON-LINEAR PROGRAMMING 12 Hrs.

LINEAR PROGRAMMING: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm.

NON LINEAR PROGRAMMING: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method – Golden section method – Interpolation methods. Unconstrained optimization Techniques.

UNIT 3 GEOMETRIC PROGRAMMING 13 Hrs.

Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty – Concept of solving problems with one degree of difficulty.

UNIT 4 DYNAMIC PROGRAMMING 12 Hrs.

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods.

UNIT 5 STRUCTURAL APPLICATIONS – Genetic Algorithms, Fuzzy optimization Techniques 12 Hrs.

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C. structures such as multistorey buildings, water tanks and bridges.

Max. 60 Hours

COURSE OUTCOME

On the end of the course, student will be able to:

- CO1 - Apply the knowledge of engineering fundamentals to formulate and solve the engineering problems by classical optimization techniques.
- CO2 - Identify, formulate and solve engineering problems by linear and non-linear programming.
- CO3 - Analyse the problem and reducing G.P.P to a set of simultaneous equations.
- CO4 - Apply the Engineering knowledge to understand the concept of dynamic programming.
- CO5 - Design various structural elements with minimum weight.
- CO6 - Explain Bellman's principle of optimality

TEXT / REFERENCE BOOKS

1. Rao, S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984
2. Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
4. Iyengar, N.G.R and Gupta, S.K, "Structural Design Optimisation", Affiliated East West Press Ltd, New Delhi, 1997.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks: 80

Exam Duration : 3 Hrs.

PART A : 6 Questions of 5 marks each – No choice - uniformly distributed

30 Marks

PART B : 2 Questions from each unit of internal choice, each carrying 10 marks

50 Marks

SCI5602	MECHANICS OF COMPOSITE MATERIALS	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

To develop an understanding of the behaviour and design study of Steel concrete composite elements and structures.

UNIT 1 INTRODUCTION**12 Hrs.**

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites and Short Fiber Composites.

UNIT 2 STRESS STRAIN RELATIONS**12 Hrs.**

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

UNIT 3 ANALYSIS OF LAMINATED COMPOSITES**12 Hrs.**

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates – Static, Dynamic and Stability analysis for Simpler cases of composite plates, Interlaminar stresses.

UNIT 4 FAILURE AND FRACTURE OF COMPOSITES**12 Hrs.**

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT 5 APPLICATIONS AND DESIGN**12 Hrs.**

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

Max. 60 Hours**COURSE OUTCOME**

On the end of the course, student will be able to:

- CO1 - Explain the various types of composites and its constituents
- CO2 - Derive the constitutive relationship and determine the stresses and strains in a composite material
- CO3 - Analyze a laminated plate and interlaminated stresses.
- CO4 - Explain the various failure criteria and fracture mechanics of composites
- CO5 - Discuss the various applications of Composites
- CO6 - Design simple composite elements

TEXT / REFERENCE BOOKS

1. Agarwal.B.D., Broutman.L.J., and Chandrashekara.K. "Analysis and Performance of Fiber Composites", John-Wiley and Sons,2006.
2. Daniel.I.M., and Ishai.O, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
3. Hyer M.W., and White S.R., "Stress Analysis of Fiber-Reinforced Composite Materials", D.Estech Publications Inc., 2009
4. Jones R.M., "Mechanics of Composite Materials", Taylor and Francis Group 1999.
5. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", Universities Press, India, 2005
6. Dattoo, "Mechanics of Fibrous Composites" Elsevier Science Publishers Ltd, 1991.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks: 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 marks each – No choice - uniformly distributed**30 Marks****PART B** : 2 Questions from each unit of internal choice, each carrying 10 marks**50 Marks**