C U R R I C U L U M

A N D

S Y L L A B U S

FOR

BACHELOR OF TECHNOLOGY (B. Tech.)

IN

COMPUTER ENGINEERING

(**Operative from 2022 - 23 Session**)

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

NATIONAL INSTITUTE OF ADVANCED MANUFACTURING TECHNOLOGY

HATIA, RANCHI - 834 003

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DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

About the Department

Department of Electronics and Computer Engineering has been established in 2020. The department envisages to support the task of transforming the Institute into an advanced research centre for manufacturing technology in the country. The enablers of such transformation, such as computer-aided design and manufacturing, computer-aided engineering, electronic control systems and devices, computer networks and security, industrial automation, data analytics, etc. will form the core of activities of this youngest department of the Institute.

Vision

To achieve excellence in engineering education by offering interdisciplinary courses pertaining to the electronics, computers, advanced manufacturing and automation domains and to develop strong competence in these domains to serve our great nation.

Mission

1) Develop up-to-date curriculum for undergraduate and postgraduate programmes, incorporating the latest and futuristic academic, research and industrial needs.
2) Develop various laboratories with state-of-the-art equipment to enable imparting of quality education.
3) Produce high calibre, competent and self-reliant engineering graduates and postgraduates, who will possess sound scientific knowledge and problem-solving skills, and engage in activities relevant to Indian industries with ethical values and flair for research.
4) Become a centre of excellence by conducting cutting-edge research in different areas of electronics, computer sciences and advanced manufacturing and by developing technology solutions for Indian manufacturing industries to ensure sustainability and self-reliance.

Courses Offered

Computer engineering graduates usually will have no knowledge and skills of manufacturing engineering graduates and vice versa. This scenario often acts as the bottleneck in realizing the full potential of advanced manufacturing. The department of electronics and computer engineering will be offering a B. Tech. course in Computer Engineering from the academic year 2022-23 to overcome such an impasse. This course will be a unique blend of computer engineering and manufacturing engineering. The students studying this course will be taught and trained on the subjects relevant to both these engineering domains, which will help them to stand apart from the regular computer engineering or manufacturing engineering graduates from other institutions. Such blending will also enable them to fetch the best of career opportunities.

B. Tech. (COMPUTER ENGINEERING)

Programme Educational Objectives (PEOs)

1) Students graduating this programme will possess sound scientific knowledge and problem-solving skills by integrating computer engineering fundamentals and advanced manufacturing engineering concepts; and

2) Students graduating this programme will have high calibre and professional competency for gainful employment in computers and manufacturing domains and sustain future challenges.

Programme Outcomes (POs)

Successful completion of the programme will enable the students with

1) Scholarship of knowledge, i.e. in-depth knowledge of the different aspects of computer science and manufacturing engineering and the ability to define, evaluate, analysis and synthesize existing and new knowledge.
2) Problem solving skills, i.e. ability to conceptualize and solve problems related to computer science and manufacturing engineering domains and evaluate optimal solutions considering economic and eco-friendly factors.
3) Critical thinking skills, i.e. the ability to critically analyse the problems apply independent judgment for synthesizing information to make intellectual and creative advances for developing new scientific knowledge in computer science and manufacturing engineering.
4) Ability to apply computer-based software tools and techniques modelling, analysis and optimization in computer and manufacturing domains.
5) Project management skills, i.e. graduates will be able to demonstrate knowledge and understanding of manufacturing engineering and management and apply the same to manage projects efficiently in respective disciplines and multidisciplinary environments with due consideration of economic and financial factors.
6) Better communication skills, i.e. ability to communicate with engineering community confidently and effectively and with the society at large by comprehending and authoring effective reports and design documentation by adhering to appropriate standards, making effective presentations, and giving and receiving clear instructions.
7) Learning skills, i.e. ability to recognize the need and develop the aptitude to engage in independent lifelong learning for continuously improving the knowledge and competence, and to observe and examine the outcomes of own actions critically and make corrective measures without depending on any external feedback.
8) Ethical practices and social responsibility, i.e. ability to acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute for sustainable development of the society.

Credits requirement for the award of degree

Minimum credits required for the award of B. Tech. degree in Computer Engineering will be 169.

Course categories and minimum credits requirements

The structure of B. Tech. degree in Computer Engineering shall have the following course categories.

S#	Course Category	No. of Subjects	No. of Credits
1)	Basic Sciences (BSC)	5	22
2)	Humanities and Social Sciences (HSS)	4	12
3)	Basic Engineering Sciences (BES)	3	12
4)	Professional Core (CEC)	22	89
5)	Electives		
	(a) Programme Electives (CPE)	7	21
	(b) Open Electives (COE)	3	09
	Total Credits		**165**

(A) BASIC SCIENCES (5 Subjects, 22 Credits)

(1) Mathematics (3 Courses, 12 Credits) (3 - 1 - 0 - 4)

(2) Physics (3 - 1 - 2 - 5)

(3) Chemistry (3 - 1 - 2 - 5)

(B) HUMANITIES AND SOCIAL SCIENCES (4 Subjects, 12 Credits)

(1) Entrepreneurship (3 - 0 - 0 - 3)

(2) English Communication for Professionals (3 - 0 - 0 - 3)

(3) Professional Ethics (3 - 0 - 0 - 3)

(4) Principles of Management (3 - 0 - 0 - 3)

(C) BASIC ENGINEERING SCIENCES (3 Subjects, 12 Credits)

(1) Basic Electrical and Electronics Engineering (3 - 0 - 4 - 5)

(2) Engineering Graphics and Design (1 - 0 - 4 - 3)

(3) Introduction to Computers and Programming (3 - 0 - 2 - 4)

(D) PROFESSIONAL CORE (20 COURSES, 81 CREDITS)

(1) Automata Theory and Compiler Design (3 - 0 - 2 - 4)

(2) Computer Networks (3 - 0 - 2 - 4)

(3) Computer Organization and Architecture (3 - 0 - 2 - 4)

(4) Cyber Physical Systems (3 - 0 - 2 - 4)

(5) Data Structures and Algorithms (3 - 0 - 2 - 4)

(6) Database Management Systems (3 - 0 - 2 - 4)

(7) Design and Analysis of Algorithms (3 - 0 - 2 - 4)

(8) Digital Electronics (3 - 0 - 2 - 4)

(9) Digital Manufacturing I (CAD/CAM) (3 - 0 - 2 - 4)

(10) Digital Manufacturing II (PLM and CAE) (3 - 0 - 2 - 4)

(11) Digital Signal Processing (3 - 0 - 2 - 4)

(12) Discrete Mathematics (3 - 1 - 0 - 4)

(13) Electrical and Control Systems (3 - 0 - 2 - 4)

(14) Engineering Mechanics (3 - 1 - 0 - 4)

(15) Manufacturing Technology (3 - 1 - 0 - 4)

(16) Materials Science and Metallurgy (3 - 0 - 2 - 4)

(17) Mechanics of Solids and Fluids (3 - 0 - 2 - 4)

(18) Object-oriented Programming (3 - 0 - 2 - 4)

(19) Operating Systems (3 - 0 - 2 - 4)

(20) Thermodynamics and Heat Transfer (3 - 0 - 2 - 4)

(21) Summer Internship (1 Credit)

The students will undergo industrial training / internship for a minimum period of 6 weeks during the summer vacation of 3rd year. Attachment with CFTIs (IISc, IIT, etc.) or technical universities in India and abroad is also allowed in lieu of industrial training. Evaluation will be carried out during the seventh semester. The evaluation will be based on technical report and seminar presentation.

(22) Project Work (8 Credits)

The project work will be carried out during the eighth semester and the evaluation will be based on a project report and seminar presentation.

(E) COMPULSORY COURSES / ACTIVITIES

These are mandatory elements of the course structure. The students will have to pass the course. No credits will be allowed.

(1) Energy and Environmental Engineering

(2) EAA (NSS / NSO / PT)

(F) PROGRAMME ELECTIVES (3 - 0 - 0 - 3)

Students shall take total of 7 programme electives (**4 from Group 1** and **3 from Group 2**). Any particular elective will be offered subject to a minimum of 40% of total students of the class opting for it. Some of these electives may have pre-requisites. A student will not be allowed to opt for the particular elective unless he/she has already done the pre-requisite course.

GROUP 1

CEPE01	Ad-hoc and Sensor Networks
CEPE02	Advanced Algorithms
CEPE03	Advanced Computer Architecture
CEPE04	Advanced Operating Systems
CEPE05	Artificial Intelligence
CEPE06	Cloud Computing
CEPE07	Computational Complexity
CEPE08	Computational Number Theory
CEPE09	Cryptography and Network Security
CEPE10	Computer Graphics
CEPE11	Data Analytics
CEPE12	Data Mining
CEPE13	Distributed Systems
CEPE14	Electronics Design and Automation
CEPE15	Embedded Systems
CEPE16	Fault Tolerant Computing
CEPE17	Formal Language and Automata Theory
CEPE18	Graph Theory
CEPE19	Human Computer Interaction
CEPE20	Image Processing
CEPE21	Information Retrieval
CEPE22	Information Theory
CEPE23	Internet of Things
CEPE24	Lower Power Circuits and Systems
CEPE25	Machine Learning
CEPE26	Mobile Computing
CEPE27	Multi-agent Systems
CEPE28	Neural Networks and Deep Learning
CEPE29	Parallel and Distributed Computing
CEPE30	Quantum Computing
CEPE31	Queuing Theory and Modelling
CEPE32	Real-time Systems

CEPE33 Signals and Networks
CEPE34 Software Engineering
CEPE35 Speech and Natural Language Processing
CEPE36 Theory of Computation
CEPE37 VLSI Systems Design
CEPE38 Web and Internet

GROUP 2

CEPE39 Additive Manufacturing
CEPE40 Advanced CAD
CEPE41 Advanced Metal Forming Technology
CEPE42 Advanced Modelling and Simulation Techniques
CEPE43 Advanced Numerical Modelling
CEPE44 Artificial Intelligence in Manufacturing
CEPE45 Automated Manufacturing Systems
CEPE46 CNC and Programming
CEPE47 Computational Geometry in Manufacturing
CEPE48 Computer Integrated Manufacturing
CEPE49 Design and Analysis of Experiments
CEPE50 Design of Machine Elements
CEPE51 Finite Element Methods and Applications
CEPE52 Flexible Manufacturing Systems
CEPE53 Geometric Modelling for Manufacturing
CEPE54 Industrial Robotics
CEPE55 Laser Applications in Manufacturing
CEPE56 Manufacture of Composite Materials
CEPE57 Manufacture of Plastics and Ceramic Products
CEPE58 Manufacturing Informatics
CEPE59 Mechatronics and Industrial Automation
CEPE60 Metrology and Computer-aided Inspection
CEPE61 Micro and Nano Manufacturing
CEPE62 Non-Destructive Testing
CEPE63 Optimization Methods for Engineers
CEPE64 Programmable Logical Controllers
CEPE65 Quality, Energy and Safety Systems
CEPE66 Reverse Engineering
CEPE67 Smart Machines
CEPE68 Sustainable Manufacturing
CEPE69 Visual Engineering

(G) OPEN ELECTIVES (OE)

CEOE01 Constitution of India
CEOE02 Cyber Laws and Ethics
CEOE03 Financial Management
CEOE04 History of Science

CEOE05	Industrial Psychology
CEOE06	Knowledge Management for Competitiveness
CEOE07	Organizational Behaviour
CEOE08	Project Management Techniques
CEOE09	Soft Computing Techniques
CEOE10	Trends in Computer Engineering
CEOE11	Trends in Advanced Manufacturing

CODING CONVENTION

The coding convention shall be as follows:

1)	Basic Sciences (BSC)	BSC$##
2)	Humanities and Social Sciences (HSS)	HSS$##
3)	Basic Engineering Sciences (BES)	BES$##
4)	Professional Core (CEC)	CEC$##
5)	Electives	
	(a) Programme Electives (CEPE)	CEPE##
	(b) Open Electives (CEOE)	CEOE##
6)	No-credit Courses	NCC$##

The symbol $ stands for semester number (1 - 8)

The symbols ## stand for two decimal numbers (01 - 99).

The practical element of a particular course will have a suffix of P after the corresponding course code.

COURSE STRUCTURE

Year	Semester	Code	Subject	L - T - P - C
I (40)	I (19)	HSS201	English Communication for Professionals	3 - 0 - 0 - 3
		BSC101	Mathematics I	3 - 1 - 0 - 4
		BSC102	Physics	3 - 1 - 0 - 4
		CEC101	Engineering Mechanics	3 - 1 - 0 - 4
		BES101	Engineering Graphics and Design	1 - 0 - 4 - 3
		BSC102P	Physics Laboratory	0 - 0 - 2 - 1
		NCC101	Extra Academic Activities (EAA)	No Credit
	II (21)	BSC201	Mathematics II	3 - 1 - 0 - 4
		BSC202	Chemistry	3 - 1 - 0 - 4
		BES201	Basic Electrical and Electronics Engineering	3 - 0 - 0 - 3
		BES202	Introduction to Computers and Programming	3 - 0 - 0 - 3
		HSS201	Professional Ethics	3 - 0 - 0 - 3
		BSC202P	Chemistry Laboratory	0 - 0 - 2 - 1
		BES201P	Basic Electrical and Electronics Engineering Laboratory	0 - 0 - 4 - 2
		BES202P	Introduction to Computers and Programming Laboratory	0 - 0 - 2 - 1
		NCC201	Extra Academic Activities (EAA)	No Credit
II (40)	I (20)	BSC301	Mathematics III	3 - 1 - 0 - 4
		CEC301	Data Structures and Algorithms	3 - 0 - 0 - 3
		CEC302	Materials Science and Metallurgy	3 - 0 - 0 - 3
		CEC303	Digital Electronics	3 - 0 - 0 - 3
		CEC304	Computer Organization and Architecture	3 - 0 - 0 - 3
		CEC301P	Data Structures and Algorithms Laboratory	0 - 0 - 2 - 1
		CEC302P	Materials Science and Metallurgy Laboratory	0 - 0 - 2 - 1
		CEC303P	Digital Electronics Laboratory	0 - 0 - 2 - 1
		CEC304P	Computer Organization and Architecture Laboratory	0 - 0 - 2 - 1
		NCC301	Extra Academic Activities (EAA)	No Credit
	II (20)	CEC401	Discrete Mathematics	3 - 1 - 0 - 4
		CEC402	Electrical and Control Systems	3 - 0 - 0 - 3
		CEC403	Mechanics of Solids and Fluids	3 - 0 - 0 - 3
		CEC404	Design and Analysis of Algorithms	3 - 0 - 0 - 3
		CEC405	Manufacturing Technology	3 - 1 - 0 - 4
		CEC402P	Electrical and Control Systems Laboratory	0 - 0 - 2 - 1
		CEC403P	Mechanics and Solids and Fluids Laboratory	0 - 0 - 2 - 1
		CEC404P	Design and Analysis of Algorithms Laboratory	0 - 0 - 2 - 1
		NCC401	Extra Academic Activities (EAA)	No Credit
III (44)	I (22)	CEC501	Operating Systems	3 - 0 - 0 - 3
		CEC502	Object Oriented Programming	3 - 0 - 0 - 3
		CEC503	Digital Signal Processing	3 - 0 - 0 - 3
		CEC504	Thermodynamics and Heat Transfer	3 - 0 - 0 - 3
		-----	Open Elective #1	3 - 0 - 0 - 3
		-----	Open Elective #2	3 - 0 - 0 - 3
		CEC501P	Operating Systems Laboratory	0 - 0 - 2 - 1
		CEC502P	Object Oriented Programming Laboratory	0 - 0 - 2 - 1
		CEC503P	Digital Signal Processing Laboratory	0 - 0 - 2 - 1
		CEC504P	Thermodynamics and Heat Transfer Laboratory	0 - 0 - 2 - 1
		NCC501	Energy and Environmental Engineering	No Credit
	II (22)	CEC601	Computer Networks	3 - 0 - 0 - 3
		CEC602	Database Management Systems	3 - 0 - 0 - 3
		CEC603	Automata Theory Compiler Design	3 - 0 - 0 - 3
		CEC604	Digital Manufacturing I (CAD / CAM)	3 - 0 - 0 - 3
		-----	Programme Elective #1	3 - 0 - 0 - 3
		-----	Programme Elective #2	3 - 0 - 0 - 3
		CEC601P	Computer Networks Laboratory	0 - 0 - 2 - 1
		CEC602P	Database Management Systems Laboratory	0 - 0 - 2 - 1
		CEC603P	Compiler Design Laboratory	0 - 0 - 2 - 1
		CEC604P	Digital Manufacturing I (CAD / CAM) Laboratory	0 - 0 - 2 - 1
IV	I	HSS701	Principles of Management	3 - 0 - 0 - 3

(41)	(20)	CEC701	Digital Manufacturing II (PLM and CAE)	3 - 0 - 0 - 3
		-----	Programme Elective #3	3 - 0 - 0 - 3
		-----	Programme Elective #4	3 - 0 - 0 - 3
		-----	Programme Elective #5	3 - 0 - 0 - 3
		-----	Open Elective #3	3 - 0 - 0 - 3
		CEC701P	Digital Manufacturing II (PLM and CAE) Laboratory	0 - 0 - 2 - 1
		CEC702	Summer Internship	0 - 0 - 0 - 1
	II (21)	HSS801	Entrepreneurship	3 - 0 - 0 - 3
		CEC801	Cyber Physical Systems	3 - 0 - 0 - 3
		-----	Programme Elective #6	3 - 0 - 0 - 3
		-----	Programme Elective #7	3 - 0 - 0 - 3
		CEC801P	Cyber Physical Systems Laboratory	0 - 0 - 2 - 1
		CEC802	Project Work	0 - 0 - 0 - 8

SYLLABUS

Course code	**HSS101**				
Category	**Humanities and Social Sciences**				
Course title	**English Communication for Professionals**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**1**
Pre-requisites if any	**-----**				

Module 1 Listening

Physical and psychological barriers to listening - Steps to overcome the barriers - Purposive listening practice - Active listening and anticipating the speaker - Use of technology in the professional world.

Module 2 Speaking

Fluency and accuracy in speech - Positive thinking - Kinds of thinking - Improving self-expression - Tonal variations - Listener oriented speaking - Group discussion practice - Interpersonal conversation - Developing persuasive speaking skills.

Module 3 Reading

Speed reading practice - Use of extensive readers - Trans-coding: verbal and nonverbal - Eye-reading practice - Analytical and critical reading practice - Introduction to ethics and values through case-study materials.

Module 4 Writing

Professional correspondence - Formal and informal letters - Argument writing practice - Perspectives in writing - Narrative writing - Different registers - Tone in formal writing - Summary writing practice - Introduction to reports.

Module 5 Study skills

Reference skills - Use of dictionary, thesaurus, etc. - Importance of contents page, cover, and back pages - Bibliography.

Textbooks / References

1) Shirley Taylor, Communication for Business, Longman, New Delhi, 1999.
2) Robert Gannon, Best Science Writing: Readings and Insights, University Press, Hyderabad, 2000.
3) Richard A. Boning, Multiple Reading Skills, McGraw-Hill, Singapore, 1990.
4) Albert J. Harris, Edward R. Sipay, How to Increase Reading Ability, Longman, New Delhi, 1990.
5) David Martin, Tough Talking, University Press, Hyderabad, 1994.

Course code	**BSC101**				
Category	**Basic Sciences**				
Course title	**Mathematics I**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**1**
Pre-requisites if any	**-----**				

Module 1 Calculus

Evolutes and involutes - Evaluation of definite and improper integrals - Beta and Gamma functions and their properties - Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2 Calculus

Rolle's theorem - Mean value theorems - Taylor's and Maclaurin theorems with remainders - Indeterminate forms and L' Hospital's rule - Maxima and minima.

Module 3 Matrices

Matrices and vectors: addition, scalar multiplication, and matrix multiplication - Linear systems of Equations - Linear Independence - Rank of a matrix - Determinants - Cramer's rule - Inverse of a Matrix - Gauss elimination and Gauss-Jordan elimination.

Module 4 Vector spaces

Vector space - Linear dependence of vectors, basis, and dimension - Linear transformations (maps), range and kernel of a linear map, rank, and nullity - Inverse of a linear transformation - Rank-nullity theorem - Composition of linear maps - Matrix associated with a linear map.

Module 5 Vector spaces

Eigenvalues and eigenvectors - Symmetric, skew-symmetric, and orthogonal matrices - Eigen bases - Diagonalization - Inner product spaces - Gram-Schmidt orthogonalization.

Textbooks / References

1) G. B. Thomas and R. L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson Reprint, 2002.
2) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3) T. Veerarajan, Engineering Mathematics for First Year, Tata McGraw-Hill, New Delhi, 2008.
4) B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, New Delhi, 11th Reprint, 2010.
5) D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
6) N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
8) V. Krishnamurthy, V. P. Mainra and J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West press, Reprint 2005.

Course code	**BSC102**				
Category	**Basic Sciences**				
Course title	**Physics**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**1**
Pre-requisites if any	**-----**				

Module 1 Harmonic oscillation

Simple harmonic motion - Damped and forced simple harmonic oscillator with examples – Damped harmonic oscillator - Heavy, critical, and light damping - Amplitude and energy decay in a damped harmonic oscillator - Forced oscillation and resonance condition.

Module 2 Wave optics

Superposition of waves - Interference, thin-film interference, and Newton's ring - Diffraction of light - Diffraction due to single slit and double slits - Unpolarized and polarized light - Polarization of wave - Production of polarized wave - Brewster's law - Malus' law - Double refraction - Retardation plate - Analysis of polarization.

Module 3 Vector calculus

Scalar and vector field - Gradient of scalar field - Divergence and Curl of vector field - Gauss' divergence theorem - Stokes' theorem.

Module 4 Electrostatics

Laplace's and Poisson's equations for electrostatic potential - Uniqueness theorem – Electric polarization - Relation between D, E and P - Electric displacement and boundary conditions - Dielectric sphere in uniform electric field.

Module 5 Magnetostatics

Biot-Savart's law and applications - Three magnetic vectors B, H and M and relation between them - Boundary conditions on B and H - Magnetic susceptibility, diamagnetic, paramagnetic, and ferromagnetic materials - Hysteresis loop - Hysteresis loss and its application.

Module 6 Maxwell's equations and electromagnetic waves

Continuity equation for current densities - Ampere's law and its modification - Differential and integral forms of Maxwell's equation - Maxwell's equation in vacuum and non-conducting medium - The wave equation - Plane electromagnetic waves in vacuum, transverse character, the relation between electric and magnetic fields of an electromagnetic wave - Energy in an electromagnetic field and Poynting theorem.

Textbooks / References

1) David Halliday, Robert Resnik and Jearl Walker, Fundamentals of Physics Electricity and Magnetism, 10th Edition, Wiley India Pvt. Ltd., 2013.
2) W. Saslow, Electricity, Magnetism and Light, Elsevier, 1st Edition, 2002.
3) K. Mamta, R. K. Singh and J. N. Prasad, Concepts of Electromagnetic Theory, I. K. International Publication, 2021.

4) S. Mahajan and S. R. Choudhury, Electricity, Magnetism and Electromagnetic Theory, Tata McGraw-Hill Pub. Co., 2017.
5) M. Sadiku, Elements of Electromagnetics, Oxford University Press, 2010.
6) F. A. Jenkins and H. E. White, Fundamentals of Optics, McGraw-Hill Inc., 1981.
7) Ajoy Ghatak, Optics, Tata McGraw-Hill Pub. Co., 2008.
8) Francis Crawford, Waves: Berkeley Physics Course, Vol. 3, Tata McGraw-Hill Pub. Co., 2007.
9) R. K. Gaur and S. L. Gupta, Engineering Physics, Dhanpat Rai Publications.
10) A. S. Vasudeva, Modern Engineering Physics, S. Chand & Co.

Course code	**CEC101**				
Category	**Professional Core**				
Course title	**Engineering Mechanics**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**1**
Pre-requisites if any	**-----**				

Module 1 Force and force systems

Force and force systems: coplanar, concurrent, and non-concurrent force systems, resultant and resolutions, forces in space, vectors, operations on force using vectors, moment of force and Varignon's theorem - Couple and its properties - Resultant of a spatial force system.

Module 2 Equilibrium, center of gravity, and moment of inertia

Equilibrium: equilibrium of a particle, external and internal forces, and equilibrium of a rigid body - Types of supports - Structural members and beams - Reactions of beams - Properties of lines, areas, and solids: center of gravity, centroid of lines (basic and composite areas), built-up sections, product of inertia, and mass moment of inertia.

Module 3 Trusses, frames, and mechanisms

Connected bodies - Two force and three force members - Trusses - Method of joints - Method of sections - Determinateness of truss, rigid and non-rigid frames - Simple mechanisms - Space frames.

Module 4 Friction

Type of friction - Characteristics of dry friction - Equilibrium on rough inclined plane - The wedge - The screw jack - Journal bearing - Axle friction - Thrust bearing - Disc friction - Clutches.

Module 5 Introduction to dynamics and kinematics

Introduction to dynamics, kinematics, and kinematics of particles in rectilinear and curvilinear motions - Projectiles - Kinematics and kinematics of a rigid body - Usage of D'Alembert's principle - Work and Energy - Impulse and momentum principles.

Textbooks / References

1) S. B. Jurnarkar and H. J. Shah, Applied Mechanics, Charotar Publishing House.
2) Merium and Kraige, Engineering Mechanics, John Wiley & Sons.

3) S. M. Sharma, Engineering Mechanics, Kirti Publications, Jammu.
4) Hughes and Martin, Engineering Mechanics, ELBS and Macmillan.
5) F. Beer and E. R. Johnson, Vector Mechanics, McGraw-Hill Co., New York.

Course code	**BES101**				
Category	**Basic Engineering Sciences**				
Course title	**Engineering Graphics and Design**				
Scheme and credits	L	T	P	C	Semester
	1	**0**	**4**	**3**	**1**
Pre-requisites if any	**-----**				

Module 1 Introduction

Graphics as language for communication - Need for instruments, scaling and upkeep of instruments - Freehand lettering - Construction of certain common curves: ellipse, parabola, and hyperbola, cycloid, and involute - Tangents to these curves.

Module 2 Orthographic projections

Need for orthographic projection - Preferring the first angle projection - Conversion of pictorial views into orthographic views - Dimensioning - IS codes.

Module 3 Solid geometry

Projection of simple solids, like cylinders, cones, prisms, pyramids, etc. with locations of specific lines or points on the surface.

Module 4 Section of solids

Need for sectioning - Exercises with simple objects like prisms, pyramids and cones - True shape of sections.

Module 5 Development and interpenetration of sheet metal components

Development of simple surfaces - Non-developable surfaces - Approximate solutions for sphere - Transition pieces - Application to sheet metal work - Interpenetration of simple solids like “prisms and prisms”, “cone and cylinder” and “cylinder and cylinder”.

Module 6 Isometric Projection

Definition of isometric projection - Isometric scales - Simple exercises on isometric views - Perspective projection of prisms and pyramids by vanishing point method.

Module 7 Overview of computer graphics

Listing the computer technologies that impact on graphical communication - Demonstrating knowledge of theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable) and The Status Bar - Different methods of zoom as used in CAD - Select and erase objects - Isometric views of lines, planes, simple and compound solids.

Module 8 Customization and CAD drawing

Setting up of drawing page and printer, including scale settings, setting up of units and drawing limits - ISO and ANSI standards for coordinate dimensioning and tolerancing - Orthographic constraints, snap to objects manually and automatically - Producing drawings by using various coordinate input entry methods to draw straight lines - Applying various ways of drawing circles.

Module 9 Applying dimensions and annotations to drawings

Setting up and use of layers, layers to create drawings, create, edit and use customized layers - Changing line lengths through modifying existing lines (extend / lengthen) - Printing documents using the print command - Orthographic projection techniques - Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface - Drawing annotations - Computer-aided design (CAD) software modelling of parts and assemblies - Parametric and nonparametric solids, surfaces, and wireframe models - Part editing and two-dimensional documentation of models - Planar projection theory including sketching of perspective, isometric, multi-view, auxiliary, and section views - Spatial visualization exercises - Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi-views of dwelling.

Module 10 Demonstration of a simple team design project

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids - Meshed topologies for engineering analysis and tool-path generation for component manufacture - Geometric dimensioning and tolerancing - Use of solid-modelling software for creating associative models at the component and assembly levels, floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. - Applying colour coding according to building drawing practice - Drawing sectional elevation showing foundation to ceiling - Introduction to Building Information Modelling (BIM).

Textbooks / References

1) SP46 - 2003, Engineering Drawing Practice for Schools and Colleges, Bureau of Indian Standards.
2) N. D. Bhatt, V. M. Panchal and P. R. Ingle, Engineering Drawing, Charotar Publishing House.
3) M. B. Shah and B. C. Rana, Engineering Drawing and Computer Graphics, Pearson Education.
4) B. Agrawal and C. M. Agrawal, Engineering Graphics, TMH.
5) K. L. Narayana and P. Kannaiah, Textbook on Engineering Drawing, Scitech Publishers.
6) Corresponding set of CAD Software Theory and User Manuals.
7) Relevant Indian and International Standards.
8) H. R. Gopalakrishna, Engineering Drawing, Subhas Stores, Bangalore, 2010.

Course code	**BSC201**				
Category	**Basic Sciences**				
Course title	**Mathematics II**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**2**
Pre-requisites if any	**-----**				

Module 1 Ordinary differential equations

Exact, linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type - Second order linear differential equations with variable coefficients - Method of variation of parameters - Cauchy-Euler equation - Power series solutions - Legendre polynomials - Bessel functions of the first kind and their properties.

Module 2 Complex variables - Differentiation

Differentiation - Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate - Elementary analytic functions (exponential, trigonometric, logarithm) and their properties - Conformal mappings - Mobius transformations and their properties.

Module 3 Complex variables - Integration

Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof) - Liouville's theorem and Maximum-Modulus theorem (without proof) - Taylor's series, zeros of analytic functions and singularities - Laurent's series - Residues: Cauchy Residue theorem (without proof) - Evaluation of definite integral involving sine and cosine - Evaluation of certain improper integrals using the Bromwich contour.

Module 4 Laplace transforms

Laplace transform of standard functions, derivatives, and integrals - Inverse Laplace transform - Convolution theorem - Periodic functions - Solution of ordinary differential equation and simultaneous equations with constant coefficients and integral equations by Laplace transform.

Module 5 Partial differential equations

Formation of partial differential equations by eliminating arbitrary constants and functions - Solution of first order equations - Four standard types - Lagrange's equation - Method of separation of variables.

Textbooks / References

1) G. B. Thomas and R. L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson Education.
2) W. E. Boyce, R. C. DiPrima and D. B. Meade, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4) S. L. Ross, Differential Equations, 3rd Edition, Wiley India, 1984.
5) E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
6) J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Edition, McGraw-Hill.
7) Ian N. Sneddon, Elements of Partial Differential Equations, Courier Corporation.

8) D. Zill, W. S. Wright, and M. R. Cullen, Advanced Engineering Mathematics, Jones & Bartlett Learning, 2011.

Course code	**BSC202**				
Category	**Basic Sciences**				
Course title	**Chemistry**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**2**
Pre-requisites if any	**-----**				

Module 1 Atomic and molecular structure

Schrodinger equation - Particle in box solutions and their applications for conjugated molecules - Molecular orbitals of diatomic molecules and plots of the multicentre orbitals - Equations for atomic and molecular orbitals - Energy level diagrams of diatomics - Bimolecular orbitals of butadiene and benzene and aromaticity - Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties - Band structure of solids and the role of doping on band structures.

Module 2 Spectroscopic techniques and applications

Principles and applications of electronic spectroscopy and nuclear magnetic resonance - Vibrational and rotational spectroscopy of diatomic molecules and its applications - Fluorescence and its applications in medicine - Surface characterisation techniques (SEM and TEM).

Module 3 Intermolecular forces

Ionic, dipolar and van Der Waals interactions - Measurement of non-covalent interaction - Hydrogen bond - Equations of state of real gases and critical phenomena.

Module 4 Use of free energy in chemical equilibria

Thermodynamic functions: energy, entropy and free energy - Estimations of entropy and free energies - Free energy and EMF - Cell potentials, the Nernst equation and applications - Acid base, oxidation reduction and solubility equilibria - Corrosion: Introduction, causes, consequences, mechanism - Laws of dry corrosion - Wet corrosion - Factors influencing corrosion - Protective measures against corrosion - Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 5 Periodic properties and Stereochemistry

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases - Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Module 6 Polymers

Classification of polymers - Mechanism of polymerisation, structure-property relationship, conductive polymers.

Textbooks / References

1) Prasanta Ratha and S. Chakroborty, Chemistry, Second Edition, Cengage Publishing.
2) Sashi Chawala, Textbook of Engineering Chemistry, 1st Edition, Dhanpat Rai Publications, 2019.
3) M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications.
4) C. N. Banwell, Fundamentals of Molecular Spectroscopy.
5) P. W. Atkins, Physical Chemistry.
6) K. P. C. Volhardt and N. E. Schore, Organic Chemistry: Structure and Function, 5th Edition.

Course code	**BES201**				
Category	**Basic Engineering Sciences**				
Course title	**Basic Electrical and Electronics Engineering**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**2**
Pre-requisites if any	**-----**				

Module 1 Elementary concepts of electric circuits

Concepts of DC electric circuits - Basic terminology including voltage, current, power, resistance and EMF - Resistances in series and parallel - Current and voltage division rules - Capacitors and inductors - V-I relations and energy stored - Ohm's and Kirchhoff's laws - Star-delta conversion (resistive networks only-derivation not required) - Problems - Analysis of DC electric circuits - Mesh current method - Matrix representation - Solution of network equations - Node voltage methods - Matrix representation - Solution of network equations by matrix methods - Numerical problems.

Module 2 Elementary concepts of magnetic circuits

Electromagnetic induction and AC fundamentals - Magnetic circuits - Basic terminology: MMF, field strength, flux density, reluctance - Comparison between electric and magnetic circuits - Series and parallel magnetic circuits with composite materials - Electromagnetic induction: Faraday's laws, problems - Lenz's law - Statically induced and dynamically induced EMFs - Self-inductance and mutual inductance - Coefficient of coupling - Alternating current fundamentals: Generation of alternating voltages - Representation of sinusoidal waveforms: frequency, period, average, RMS values and form factor of waveforms - Numerical Problems.

Module 3 AC circuits

Phasor representation of sinusoidal quantities - Trigonometric, rectangular, polar and complex forms - Analysis of simple AC circuits: purely resistive, inductive and capacitive circuits - Inductive and capacitive reactance - Concept of impedance - Average power factor - Analysis of RL, RC and RLC series circuits - Active, reactive and apparent power - - Three phase AC systems: generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents - Simple numerical problems.

Module 4 Introduction to semiconductor devices

Evolution of electronics - Vacuum tubes to nano electronics - Resistors, capacitors and inductors (constructional features not required): types, specifications - Standard values and colour coding - PN

Junction diode: principle of operation, V-I characteristics, principle of avalanche breakdown - Bipolar Junction Transistors: PNP and NPN structures - Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration.

Module 5 Basic electronic circuits and instrumentation

Rectifiers and power supplies - Block diagram description of a DC power supply - Working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator - Amplifiers: block diagram of public address system - Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response - Concept of voltage divider biasing - Electronic instrumentation: block diagram of an electronic instrumentation system.

Textbooks / References

1) D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2010.
2) Floyd, Electronic Devices, Pearson Education, 9th Edition, 2012.

Course code	**BES202**				
Category	**Basic Engineering Sciences**				
Course title	**Introduction to Computers and Programming**				
Scheme and credits	L	T	P	C	Semester
	2	**0**	**0**	**2**	**2**
Pre-requisites if any	**-----**				

Module 1

Elements of a digital computer - Typical digital computer organization - Memory storage and I/O devices: principles of core memory, basics of RAM, ROM, magnetic discs and printers - Problem solving: steps to solve logical and numerical problems - Representation of algorithms: flowcharts and pseudo codes - From algorithms to programs: source code, variables (with data types) variables and memory locations - Syntax and logical errors in compilation, object and executable code - Binary algebra and applications.

Module 2

Arithmetic expressions and precedence - Conditional branching and loops - Writing and evaluation of conditionals, iterations, and loops.

Module 3

Arrays - Character arrays - Strings - Case studies to discuss the various problems related to basic sciences (matrix addition, matrix-matrix multiplication, roots of an equation, etc.) - Sorting - Searching.

Module 4

Functions and uses - Parameter passing in functions: call by value and call by reference - Passing arrays to functions - Recursion (finding factorial, Fibonacci series, Ackerman function, etc.).

Module 5

Structures: defining structures and array of structures - Pointers: defining pointers, use of pointers in self-referential structures - File handling.

Textbooks / References

1) Thomas C. Bartee, Digital Computer Fundamentals, McGraw-Hill Co.
2) W. Gear, Computer Organization and Programming, McGraw-Hill Co.
3) V. Rajaraman and T. Radhakrishnan, An Introduction to Digital Computer Design, Prentice Hall of India.
4) Jery R. Hanly, Problem Solving and Program design in C, 7th Edition, Pearson Education.
5) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill Co.
6) Reema Thareja, Introduction to C Programming, 2nd Edition, Oxford University Press, 2015.
7) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall.
8) Byron Gottfried, Schaum's Outline of Programming with C, Tata McGraw-Hill Co.

Course code	**HSS201**				
Category	**Humanities and Social Sciences**				
Course title	**Professional Ethics**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**2**
Pre-requisites if any	**-----**				

Module 1 Human values

Morals, values, and ethics - Integrity - Work ethics - Service learning - Civic virtue respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Cooperation - Commitment - Empathy - Self-confidence - Character - Spirituality - Introduction to Yoga and meditation for professional excellence and stress management.

Module 2 Engineering Ethics

Senses of engineering ethics - Variety of moral issues - Types of inquiry - Moral dilemmas - Moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of professional roles - Theories about right action - Self-interest - Customs and religion - Uses of ethical theories.

Module 3 Engineering as social experimentation

Engineering as experimentation - Engineers as responsible experimenters - Codes of ethics - A balanced outlook on law.

Module 4 Safety, responsibilities, and rights

Safety and risk - Assessment of safety and risk - Risk benefit analysis and reducing risk - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights - Intellectual Property Rights (IPR) - Discrimination.

Module 5 Global issues

Multinational corporations - Environmental ethics - Computer ethics - Weapons development - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership - Code of conduct - Corporate Social Responsibility (CSR).

Textbooks / References

1) Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw-Hill Co., New Delhi, 2003.
2) M. Govindarajan, S. Natarajan and V. S. Senthil Kumar, Engineering Ethics, Prentice Hall of India, New Delhi, 2004.

Course code	**BSC301**				
Category	**Basic Sciences**				
Course title	**Mathematics III**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**3**
Pre-requisites if any	**-----**				

Module 1 Basic probability

Probability spaces, conditional probability, and independence - Discrete random variables, independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, and sums of independent random variables - Expectation of discrete random variables, moments, variance of a sum, and correlation coefficient - Chebyshev's inequality.

Module 2 Continuous probability distributions

Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Module 3 Bivariate distributions

Bivariate distributions and their properties, distribution of sums and quotients, and conditional densities - Bayes' rule.

Module 4 Basic statistics

Measures of central tendency: moments, skewness and kurtosis - Probability distributions: Binomial, Poisson and Normal - Evaluation of statistical parameters for these three distributions, correlation and regression - Rank correlation.

Module 5 Applied statistics

Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves - Test of significance: large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Module 6 Small samples

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Textbooks / References

1) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

2) P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003.
3) S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4) W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.
5) N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, 2010.
6) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7) T. Veerarajan, Engineering Mathematics, Tata McGraw-Hill Co., New Delhi, 2010.

Course code	**CEC301**				
Category	**Professional Core**				
Course title	**Data Structures and Algorithms**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**3**
Pre-requisites if any	**C Programming Language**				

Module 1

Introduction - Basic terminology - Elementary data organization - Built-in data types in C - Algorithms: analyzing algorithms, complexity of algorithms, time and space complexity - Asymptotic notations: Big Oh, Big Theta and Big Omega - Time-space trade-off - Abstract Data Types (ADT) - Arrays: definition, single and multidimensional arrays - Representation of arrays: row major order, and column major order - Derivation of index formulae for 1-D, 2-D, 3-D and n-D array application of arrays - Sparse matrices and their representations - Linked lists: Array implementation and pointer implementation of singly linked lists, doubly linked list, and circularly linked list - Operations on a linked list: insertion, deletion, and traversal - Polynomial representation and addition subtraction and multiplications of single variable and two variables polynomial.

Module 2

Stacks: abstract data type, primitive stack operations: push and pop, array and linked - Implementation of stack in C - Application of stack - Prefix and postfix expressions - Evaluation of postfix expression - Iteration and recursion: principles of recursion, tail recursion, removal of recursion - Problem solving using iteration and recursion with examples such as binary search, Fibonacci numbers, and Hanoi towers - Tradeoffs between iteration and recursion - Queues - Operations on queues: create, add, delete, full and empty, and circular queues - Array and linked implementation of queues in C - Dequeue and priority queue.

Module 3

Searching: concept of searching, sequential search, index sequential search, and binary search - Concept of hashing and collision resolution - Techniques used in hashing - Sorting: insertion sort, selection, bubble sort, quick sort, merge sort, heap sort, and radix sort.

Module 4

Graphs: terminologies used - Data structure for graph representations: adjacency matrices, adjacency list, adjacency. graph traversal: depth first search and breadth first search, connected component,

spanning trees - Minimum cost spanning trees: Prims and Kruskal algorithm - Transitive closure and shortest path algorithm: Warshal algorithm and Dijikstra algorithm.

Module 5

Trees: basic terminology used with trees - Binary trees - Binary tree representation: array representation and pointer (linked list) representation, binary search tree, strictly binary tree, complete binary tree - Extended binary trees - Tree traversal algorithms: in-order, pre-order, and post-order - Constructing binary tree from given tree traversal - Operation of insertion, deletion, searching and modification of data in binary search - Threaded binary trees - Traversing threaded binary trees - Huffman coding using binary tree - Concept and basic operations for AVL-tree , B-tree and binary heaps.

Textbooks / References

1) A. M. Tenenbaum, Y. Langsam and M. J. Augenstein, Data Structures using C and C++, PHI Learning Private Limited, Delhi.
2) Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publications Pvt. Ltd., Delhi.
3) Lipschutz, Data Structures, Schaum's Outline Series, Tata McGraw-Hill Education (India) Pvt. Ltd.
4) Thareja, Data Structure using C, Oxford Higher Education.
5) A. K. Sharma, Data Structure using C, Pearson Education India.

Course code	**CEC302**				
Category	**Professional Core**				
Course title	**Materials Science and Metallurgy**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**3**
Pre-requisites if any	**-----**				

Module 1

Crystal Structure: BCC, FCC, and HCP structures - Coordination number and atomic packing factors - Crystal imperfections: point, line and surface imperfections - Atomic diffusion phenomenon - Flick's laws of diffusion - Factors affecting diffusion - Mechanical behavior: stress-strain diagram for ductile and brittle materials, true stress and true strain, linear and nonlinear elastic behavior and properties, mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, and toughness - Plastic deformation of single crystal by slip and twinning.

Module 2

Fracture: Type I, Type II, and Type III - Creep: description of the phenomenon with examples, three stages of creep, creep properties and stress relaxation - Fatigue: types of fatigue loading with examples, mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.

Module 3

Solidification and solid solutions: mechanism of solidification, homogeneous and heterogeneous nucleation, crystal growth, cast metal structures, and solid solutions: types and rules governing the

formation of solid solutions. Phase diagram: basic terms, phase rule, lever rule, cooling curves, construction, and interpretation of different phase diagrams (eutectic, eutectoid, peritectic and peritectoid).

Module 4

Heat treatment of metals: TTT curves, continuous cooling curves, annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, and surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening - Age hardening of Aluminum-Copper alloys - Ferrous materials: properties, composition and uses of grey cast iron, malleable iron, SG iron and steel - Non-ferrous metals: Copper alloys - brasses and bronzes. Aluminum alloys - Al-Cu, Al-Si, and Al-Zn alloys.

Module 5

Composite materials: definition, classification, types of matrix materials and reinforcements, fundamentals of production of FRPs and MMCs, advantages and application of composites - Other materials: brief description of other materials such as optical and thermal materials smart materials - fiber optic materials, piezo-electrics, shape memory alloys shape memory alloys - Nitinol - Super elasticity - Biological applications of smart materials - Materials used as implants in human body - Selection of materials - Performance of materials in service residual life assessment - Use of non-destructive testing, economics, environment and sustainability.

Textbooks / References

1) Smith, Foundations of Materials Science and Engineering, 3rd Edition, McGraw-Hill Co., 2009.
2) Shackleford and Muralidhara, Materials Science, Pearson Publication, 2007.
3) Alan Cottrell, An introduction to Metallurgy, University Press India Oriental Longman Pvt. Ltd., 1974.
4) V. Raghavan, Materials Science and Engineering, PHI, 2002.
5) H. van Vlack, Elements of Materials Science and Engineering, Addison - Wesley, 1998.
6) William D. Callister Jr., Materials Science and Engineering, John Wiley & Sons, Inc., 5th Edition, 2001.

Course code	**CEC303**				
Category	**Professional Core**				
Course title	**Digital Electronics**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**3**
Pre-requisites if any	**-----**				

Module 1

Basics of digital electronics - Number representation: binary number system, number base conversion, octal, hexadecimal and BCD codes - Binary arithmetic - Logic gates - Logic families: TTL, ECL, and CMOS - Logic circuits: logic levels, voltages and currents, fan-in, fan-out, speed, and power dissipation - Comparison of logic families.

Module 2

Simplification of Boolean functions: Boolean algebra, basic theorems and properties, De Morgan's theorem, canonical, and standard forms, simplification of Boolean function using Karnaugh map, and POS and SOP simplification - Prime implicant - NAND and NOR implementation.

Module 3

Design of combinational circuits: analysis and design procedure, parity generators and checkers, adders, subtractors, look ahead carry / adder, 4-bit BCD adder / subtractor, magnitude comparator, decoders, encoders, multiplexers, and de-multiplexers - Design of 1-bit ALU for basic logic and arithmetic operations.

Module 4

Design of sequential circuits and memories: basic latch, flip-flops (SR, D, JK, T and Master-Slave) - Triggering of flip-flops - Synchronous and asynchronous counters - Registers - Shift Registers - Memories and programmable logic design: types of memories, memory expansion and its decoding, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL).

Module 5

Counters: classification, ripple or asynchronous counter, effect of propagation delay in ripple counters, up-down counter, design of mod-n counter, synchronous counter, ring counter, and Johnson counter - Introduction to FSM - Design of synchronous FSM - Algorithmic state machines charts - Designing synchronous circuits like pulse train generator - Concepts of programmable logic devices like FPGA - Logic implementation using programmable devices - VLSI design flow: design entry, schematic, FSM and HDL - Different modeling styles in VHDL - Data types and objects - Dataflow - Behavioral and structural modeling, synthesis and simulation - VHDL constructs and codes for combinational and sequential circuits.

Textbooks / References

1) Morris Mano and Michael D. Ciletti , Digital Design, 5th Edition, PHI.
2) Charles H Roth, Digital System Design using VHDL, Thomson Learning.
3) A. P. Malvino, Digital Computer Electronics, 3rd Edition, McGraw-Hill Co.
4) A. Anand Kumar, Fundamentals of Digital Circuits, PHI.

Course code	**CEC304**				
Category	**Professional Core**				
Course title	**Computer Organization and Architecture**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**3**
Pre-requisites if any	**-----**				

Module 1

Introduction - Functional units of digital systems and their interconnections, buses, bus architecture, types of buses and bus arbitration - Register, bus, and memory transfer - Processor organization, general registers organization, stack organization and addressing modes.

Module 2

Arithmetic and logic unit: look ahead carries adders - Multiplication: signed operand multiplication, Booth's algorithm, and array multiplier - Division and logic operations - Floating point arithmetic operation - Arithmetic and logic unit design - IEEE standard for floating point numbers.

Module 3

Control unit: instruction types, formats, instruction cycles and sub cycles (fetch and execute, etc.), micro-operations, and execution of a complete instruction - Program control - Reduced Instruction Set Computer (RISC) - Pipelining - Hardwire and micro-programmed control: micro program sequencing, and concepts of horizontal and vertical microprogramming.

Module 4

Memory: basic concepts and hierarchy, semiconductor RAM memories, 2D and 2½D memory organization - ROM memories - Cache memories: concept and design issues and performance, address mapping and replacement - Auxiliary memories: magnetic disk, magnetic tape, and optical disks - Virtual memory: concept implementation.

Module 5

Input / Output (I/O): peripheral devices, I/O interface, and I/O ports - Interrupts: interrupt hardware, types of interrupts and exceptions - Modes of data transfer: programmed I/O, interrupt initiated I/O and Direct Memory Access (DMA) - I/O channels and processors - Serial communication: synchronous and asynchronous communication - Standard communication interfaces.

Textbooks / References

1) M. Mano, Computer System Architecture.
2) C. Hamacher, Z. Vranesic and S. Zaky, Computer Organization, McGraw-Hill Co., 5th Ed., 2012.
3) John P. Hayes, Computer Architecture and Organization, Tata McGraw-Hill, Third Edition, 1998.
4) William Stallings, Computer Organization and Architecture - Designing for Performance, Pearson Education, Seventh Edition, 2006.
5) Behrooz Parahami, Computer Architecture, Oxford University Press, Eighth Impression, 2011.
6) David A. Patterson and John L. Hennessy, Computer Architecture - A Quantitative Approach, Read India Private Limited, Fifth Edition, 2012.
7) Tannenbaum, Structured Computer Organization, PHI.

Course code	**CEC401**				
Category	**Professional Core**				
Course title	**Discrete Mathematics**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**4**
Pre-requisites if any	**-----**				

Module 1 Sets, relations, and functions

Basic operations on sets - Cartesian products, disjoint union (sum), and power sets - Different types of relations, their compositions, and inverses - Different types of functions, their compositions, and inverses.

Module 2 Propositional logic

Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deduction theorem, etc. - Decision problems of propositional logic - Introduction to first order logic and first order theory.

Module 3 Partially ordered sets

Complete partial ordering, chain, lattice, complete, distributive, modular and complemented lattices - Boolean and pseudo-Boolean lattices.

Module 4 Algebraic structures

Algebraic structures with one binary operation - Semigroup, monoid, and group - Cosets, Lagrange's theorem, normal subgroup, and homomorphic subgroup - Congruence relation and quotient structures - Error correcting code - Algebraic structures with two binary operations ring, integral domain, and field - Boolean algebra and Boolean ring (definitions and simple examples only).

Module 5 Introduction to counting

Basic counting techniques - Inclusion and exclusion, pigeon-hole principle, permutation, combination, and summations - Introduction to recurrence relation and generating functions.

Module 6 Introduction to graphs

Graphs and their basic properties - Degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, and trees.

Textbooks / References

1) C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
2) R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
3) R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
4) K. H. Rosen, Discrete Mathematics and its Applications, 6th Ed., Tata McGraw-Hill, 2007.
5) J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010.
6) S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.

7) N. Deo, Graph Theory, Prentice Hall of India, 1974.
8) J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.

Course code	**CEC402**				
Category	**Professional Core**				
Course title	**Electrical and Control Systems**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**4**
Pre-requisites if any	**-----**				

Module 1

Introduction - Magnetic circuits and transformers, rotating magnetic fields and machines - Magnetic circuit concepts - DC and AC excitation of ferromagnetic structures - Ideal and actual transformers - Equivalent circuits and analysis of transformers - Auto transformers and three-phase transformers.

Module 2

Electrical energy conversion principles - Energy balance - Energy in singly excited and multiply excited magnetic systems - Basic concepts of rotating machines - Generated voltage - MMF of distributed windings - Rotating magnetic fields - Torque in non-salient pole machines - Commutator action - Important characteristics of DC, synchronous and induction motors, and generators.

Module 3

Basic concepts and notion of feed-back - Open- and closed-loop systems - Modeling and representations of control systems - Ordinary differential equations - Transfer functions - Block diagrams - Signal flow graphs - State-space representations.

Module 4

Performance and stability - Time-domain analysis - Second-order systems - Characteristic equation and roots - Routh-Hurwitz criteria - Frequency-domain techniques: root-locus methods - Frequency responses - Bode plots - Gain-margin and phase-margin - Nyquist plots - Compensator design: proportional, PI and PID controllers - Lead-lag compensators.

Module 5

State-space concepts - Controllability - Observability - Minimal representations.

Textbooks / References

1) A. E. Fitzgerald, C. Kingsley, Jr., and S. D. Umars, Electrical Machinery, McGraw-Hill Co., 1983.
2) I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw-Hill Co., 1985.
3) J. C. Doyle, B. A. Francis and A. R. Tannenbaum, Feedback Control Theory, Maxwell Macmillan, 1992.
4) G. Franklin, J. D. Powell and A. Emami-Naeini, Feedback Control of Dynamic Systems, Addison Wesley, 1986.
5) I. J. Nagrath and M. Gopal, Control System Engineering, 2nd Ed., Wiley Eastern, New Delhi, 1982.

Course code	**CEC403**				
Category	**Professional Core**				
Course title	**Mechanics of Solids and Fluids**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**4**
Pre-requisites if any	**-----**				

Module 1 Deformation of solids and bending of beams

Concept of stress and strain - Normal and shear stresses - Simple and compound stresses - Elasticity and elastic moduli - Poisson's ratio - Concept of shear force and bending moment - Bending moment and shear force diagrams for simply supported, cantilever and overhanging beams.

Module 2 Shafts and springs

Torsion - Shear stresses in circular solid and hollow shafts - Torque and power - Helical and leaf springs - Load, deflection, stress and stiffness relationships.

Module 3 Fluid property and flow characteristics

Surface tension - Capillarity - Viscosity - Newton's law - Fluid pressure and pressure head - Fluid velocity - Uniform and steady flow - Reynolds number - Classification as laminar and turbulent flow - Continuity equation.

Module 4 Flow dynamics and measurement in pipe networks

Euler's and Bernoulli's Equations - Manometer, venturi meter and orifice meter - Pressure losses along the flow - Categorisation into minor losses - Flow through circular pipes - Statement of Darcy-Weisbach equation - Friction factor - Pipes in series and parallel - Hydraulic gradient.

Module 5 Turbines and pumps

Introduction and classification of turbines - Specific speed - Turbine characteristics - Speed governance - Classification of pumps - Centrifugal pumps - Impeller blade profiles - Cavitation in pumps - Pump characteristics - Efficiency - Reciprocating pumps - Classification.

Textbooks / References

1) R. K. Rajput, Strength of Materials (Mechanics of Solids), S. Chand & Company Ltd., 2003.
2) K. L. Kumar, Engineering Fluid Mechanics, S. Chand & Company Ltd., 2002.
3) R. K. Bansal, Strength of Materials, Lakshmi Publications (P) Ltd, 2004.
4) R. K. Bansal, A Textbook on Fluid Mechanics & Hydraulic Mechanics, Lakshmi Publications (P) Ltd, 2004.

Course code	**CEC404**				
Category	**Professional Core**				
Course title	**Design and Analysis of Algorithms**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**4**
Pre-requisites if any	**-----**				

Module 1

Introduction to algorithms - Analysing algorithms - Complexity of algorithms - Growth of functions - Performance measurements: recurrence relation, substitution method, iteration method, recursion tree method and master method - Sorting and order statistics - shell sort, quick sort, merge sort and heap sort - Comparison of sorting algorithms - Sorting in linear time.

Module 2

Advanced data structures: Red-Black Trees, B-Trees, Binomial Heaps, Fibonacci Heaps, Tries and Skip List.

Module 3

Divide and conquer with examples such as sorting, matrix multiplication, convex hulls and searching - Greedy methods with examples such as optimal reliability allocation, Knapsack, Minimum Spanning Trees - Prim's and Kruskal's Algorithms - Single source shortest paths - Dijkstra's and Bellman Ford Algorithms.

Module 4

Dynamic programming with examples such as Knapsack - All pair shortest paths - Warshal's and Floyd's Algorithms - Resource allocation problem - Backtracking - Branch and bound with examples such as traveling salesman problem, graph colouring, n-Queen Problem, Hamiltonian cycles and sum of subsets.

Module 5

Algebraic computation - Fast Fourier transforms - String matching - Theory of NP-Completeness, Approximation algorithms and Randomized algorithms.

Textbooks / References

1) T. H. Coreman, C. E. Leiserson and R. L. Rivest, Introduction to Algorithms, Prentice Hall of India.
2) E. Horowitz, S. Sahni, and S. Rajasekaran, Fundamentals of Computer Algorithms, Universities Press.
3) A. Aho, J. Hopcraft and J. Ullman, The Design and Analysis of Computer Algorithms, Pearson Education.
4) R. C. T. Lee, S. S. Tseng, R. C. Chang and Y. T. Tsai, Introduction to the Design and Analysis of Algorithms, McGraw-Hill Education.
5) R. E. Neapolitan, Foundations of Algorithms, Jones & Bartlett Learning.
6) J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education.
7) M. T. Goodrich and R. Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006.
8) H. R. Lewis and L. Denenberg, Data Structures and their Algorithms, Harper Collins, 1997.

Course code	**CEC405**				
Category	**Professional Core**				
Course title	**Manufacturing Technology**				
Scheme and credits	L	T	P	C	Semester
	3	**1**	**0**	**4**	**4**
Pre-requisites if any	**-----**				

Module 1 Metal casting processes

Sand casting - Type of patterns - Pattern materials - Pattern allowances - Moulding sand properties and testing - Cores: types and applications - Moulding machines: types and applications - Melting furnaces: Blast and Cupola furnaces - Principles of special casting processes, such as shell moulding, investment casting, ceramic moulding, pressure die casting, centrifugal casting, CO_2 process and stir casting - Defects in sand castings.

Module 2 Metal joining processes

Operating principle, basic equipment, merits and applications of fusion welding processes - Gas welding: types and flame characteristics - Manual metal arc welding, Gas Tungsten arc welding, Gas metal arc welding, submerged arc welding and electroslag welding - Operating principles and applications of resistance welding, plasma arc welding. thermit welding, electron beam welding, friction welding and friction stir welding - Brazing and soldering - Weld defects: types, causes and cure.

Module 3 Metal forming processes

Hot working and cold working of metals - Forging processes: open, impression and closed die forging - Forging operations - Rolling of metals: types of rolling - Flat strip rolling and shape rolling operations - Defects in rolled parts - Principle of rod and wire drawing - Tube drawing - Principles of extrusion - Hot and cold extrusion.

Module 4 Sheet metal processes

Sheet metal characteristics - Shearing, bending, and drawing operations - Stretch forming operations - Formability of sheet metal: test methods - Special forming processes: working principle and applications - Hydroforming - Rubber pad forming - Metal spinning - Introduction of explosive forming, magnetic pulse forming, peen forming and superplastic forming - Micro forming.

Module 5 Manufacture of plastic components

Types and characteristics of plastics - Moulding of thermoplastics - Working principles and typical applications - Injection moulding - Plunger and screw machines - Compression moulding - Transfer moulding - Typical industrial applications - Introduction to blow moulding - Rotational moulding - Film blowing - Extrusion - Thermoforming - Bonding of thermoplastics.

Module 6 Modern developments

Numerical control (NC) and computer numerical control (CNC) machines - Basics elements of CNC - 2-axis, 2½-axis and 3-axis machines - Multiple axis machines - Conditions where CNC machines are

most suitable - Economics of NC machines - Programming for NC machining - Non-conventional manufacturing processes, such as EDM, ECM, CHM, etc.

Textbooks / References

1) A. Ghosh and A. K. Mallik, Manufacturing Science.
2) P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding.
3) J. Schey, Introduction to Manufacturing Processes.
4) E. P. DeGarmo, T. J. Black and R. A. Kohser, Materials and Processes in Manufacturing.
5) S. R. Schmid and S. Kalpakjian, Manufacturing Process for Engineering Materials.

Course code	**CEC501**				
Category	**Professional Core**				
Course title	**Operating Systems**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**5**
Pre-requisites if any	**-----**				

Module 1

Introduction - Operating system and functions - Classification of operating systems: batch, interactive, time-sharing, real-time system, multiprocessor systems, multiuser Systems, multi-process systems and multithreaded systems - Operating system structure - Layered structure - System components Operating system services - Re-entrant kernels - Monolithic and microkernel systems.

Module 2

Concurrent processes: process concepts, principle of concurrency, producer / consumer problem, mutual exclusion, critical section problem, Dekker's solution, Peterson's solution, semaphores, test and set operation - Classical problems in concurrency: dining philosopher problem and sleeping barber problem - Inter-process communication models and schemes - Process generation.

Module 3

CPU scheduling: scheduling concepts, performance criteria, process states, process transition diagram, schedulers, process control block (PCB), process address space, process identification information and threads and their management - Scheduling algorithms - Multiprocessor scheduling - Deadlock: system model, deadlock characterization, prevention, avoidance, detection and recovery.

Module 4

Memory management: basic bare machine, resident monitor, multiprogramming with fixed partitions, multiprogramming with variable partitions, protection schemes, paging, segmentation, paged segmentation - Virtual memory concepts - Demand paging - Performance of demand paging - Page replacement algorithms - Thrashing - Cache memory organization - Locality of reference.

Module 5

Input / Output (I/O) management and disk scheduling: I/O devices and I/O subsystems, I/O buffering, Disk storage and disk scheduling, RAID - File system: file concepts, file organization and access

mechanism - File directories and file sharing - File system implementation issues - File system protection and security.

Textbooks / References

1) Silberschatz, Galvin and Gagne, Operating Systems Concepts, Wiley Publications.
2) Sibsankar Halder and Alex A. Aravind, Operating Systems, Pearson Education.
3) Harvey M. Dietel, An Introduction to Operating System, Pearson Education.
4) D. M. Dhamdhere, Operating Systems: A Concept based Approach, 2nd Edition.
5) Charles Crowley, Operating Systems: A Design-Oriented Approach, Tata McGraw Hill Co.
6) Stuart E. Madnick and John J. Donovan, Operating Systems, McGraw Hill Co.

Course code	**CEC502**				
Category	**Professional Core**				
Course title	**Object-oriented Programming**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**5**
Pre-requisites if any	**Knowledge of C++ and Java, and/or Pearl.**				

Module 1

Abstract data types and their specification - How to implement an ADT - Concrete state space, concrete invariant, abstraction function - Implementing operations, illustrated by the text example.

Module 2

Features of object-oriented programming - Encapsulation, object identity, polymorphism - but not inheritance.

Module 3

Inheritance in OO design - Design patterns: introduction and classification - The iterator pattern - Model-view-controller pattern - Commands as methods and as objects - Implementing OO language features.

Module 4

Memory management - Generic types and collections.

Module 5

GUIs - Graphical programming with Scala and Swing - The software development process.

Textbooks / References

1) Barbara Liskov, Program Development in Java, Addison-Wesley, 2001.
2) Any book on Core Java.
3) Any book on C++.

Course code	**CEC503**				
Category	**Professional Core**				
Course title	**Digital Signal Processing**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**5**
Pre-requisites if any	**-----**				

Module 1 Introduction to digital signal processing

Discrete time signals and systems - Linear shift invariant systems - Stability and causality - Discrete time systems described by difference equations - Frequency domain representation of discrete time signals and systems.

Module 2 Fourier series and Fourier transforms

Discrete Fourier series representation of periodic sequences - Properties of discrete Fourier series - Discrete Fourier transforms: frequency domain sampling, linear convolution of sequences using DFT, computation of DFT, relationship of DFT to other transforms and properties of DFT - Fast Fourier transforms (FFT) - Radix-2 FFT algorithm - Radix-4 FFT algorithm - Inverse FFT.

Module 3 Z-transforms and realization of digital filters

Review of Z-transforms - Properties of Z-transforms - Rational Z-transforms - Inversion of Z-transforms, stability and causality - Structures for FIR systems: direct form structure, cascade form structures - Structures for IIR systems: direct form structures, signal flow graphs and transposed structures, cascade form structures and parallel form structures.

Module 4 Design of FIR and IIR digital filters

Symmetric and antisymmetric FIR filters - Design of linear phase FIR digital filters using Windows - Design of linear phase FIR digital filters by frequency sampling method - IIR filter design by approximation of derivatives - IIR filter design by impulse invariance - IIR filter design by bilinear transformation - Characteristics of commonly used analog filters (Butterworth and Chebyshev) - Frequency transformations - Comparison of IIR and FIR filters.

Module 5 Multi-rate digital signal processing

Decimation by a factor D - Interpolation by a factor I - Sampling rate conversion by a rational factor I/D - Filter design and implementation for sampling rate conversion - Multi-stage implementation of sampling rate conversion.

Textbooks and References

1) J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, Pearson Education / PHI, India, 2007.
2) A. V. Oppenheim and R. W. Schaffer, Discrete Time Signal Processing, Prentice Hall of India, New Delhi, 2009.
3) Andreas Antoniou, Digital Signal Processing, Tata McGraw Hill, New Delhi, 2006.
4) M. H. Hayes, Schaum's Outlines of Digital Signal Processing, Tata McGraw Hill, India, 2007.

Course code	**CEC504**				
Category	**Professional Core**				
Course title	**Thermodynamics and Heat Transfer**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**5**
Pre-requisites if any	**-----**				

Module 1 Introduction

Definition and scope of engineering thermodynamics - Value of energy to society: microscopic versus macroscopic viewpoints - Concepts and definitions: system, surroundings, boundary and universe - Closed systems, open systems, and isolated systems - Thermodynamic properties: intensive, extensive and specific properties - Thermodynamic equilibrium state, process, and path, cyclic process, quasi-equilibrium process, reversible and irreversible process - Common properties: pressure, specific volume and temperature - Zeroth law of thermodynamics - Equality of temperature.

Module 2 Energy and energy transfer

Energy and its meaning - Stored energy and transient energy - Total energy - Energy transfer - Heat transfer - Work transfer - Expressions for displacement, work transfer and power.

Module 3 Properties of common substances

Pure substance and state postulate - Ideal gas and ideal gas relations - Two phase (liquid and vapor) systems: phase change, subcooled liquid, saturated liquid, wet mixture, critical point, quality, moisture content, saturated vapor and superheated vapor - Properties of two-phase mixture - Other thermodynamic properties: internal energy, enthalpy and specific heat - Development of property data: graphical data presentation and tabular data presentation.

Module 5 First law of thermodynamics

First law of thermodynamics for control mass - First law of thermodynamics for control mass undergoing cyclic process - First law of thermodynamics for control volume - Control volume analysis: steady state analysis and unsteady state analysis - Control volume application: steady and unsteady work applications and steady and unsteady flow applications - Other statements of the first law.

Module 5 Second law of thermodynamics

Necessity of formulation of second law - Entropy and second law of thermodynamics for an isolated system - Reversible and irreversible processes - Entropy and process relation for an ideal gases and incompressible substances - Control mass and control volume formulation of second law - Isentropic process for an ideal gas and for incompressible substances - Carnot cycle, Carnot efficiency, heat engine and thermal efficiency, heat pump, refrigerator and coefficient of performance (COP), Kelvin-Planck and Clausius statements of the second law of thermodynamics and their equivalence.

Module 6 Introduction to heat transfer

Basic concepts and modes of heat transfer - One dimensional steady state heat conduction through a plane wall - Radial steady state heat conduction through a hollow cylinder - Heat flow through composite structures, composite plane wall and multilayer tubes - Electrical analogy for thermal

resistance - Combined heat transfer and overall heat transfer coefficient for plane wall and tube - Nature of convection: free and forced convection, heat radiation, Stefan's law, absorptivity, reflectivity and transmissivity - Black body, white body and grey body.

Textbooks / References

1) E. Radhakrishnan, Engineering Thermodynamics, Tata McGraw-Hill.
2) J. R. Howell and R. O. Buckius, Fundamentals of Engineering Thermodynamics, McGraw-Hill Co.
3) R. E. Sonntag, C. Borgnakke, G. J. Van Wylen, Fundamentals of Thermodynamics, 7th Ed., Wiley.
4) M. J. Moran and H. N. Shapiro, Fundamentals of Engineering Thermodynamics, 5th Edition, John Wiley & Sons, Inc.
5) Y. A. Cengel and M. A. Boles, Thermodynamics: An Engineering Approach, 5th Edition, McGraw-Hill Co.
6) J. P. Holman, Heat Transfer, McGraw-Hill Co.
7) Y. A. Cengel, Heat Transfer: A Practical Approach, 2nd Edition, McGraw-Hill Co.

Course code	**NCC501**				
Category	**No-credit Courses**				
Course title	**Energy and Environmental Engineering**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**0**	**5**
Pre-requisites if any	**-----**				

Module 1 Introduction to energy science

Introduction to energy systems and resources - Introduction to energy, sustainability and the environment - Overview of energy systems, sources, transformations, efficiency and storage - Fossil fuels (coal, oil, oil-bearing shale and sands and coal gasification): past, present and future - Remedies and alternatives for fossil fuels: biomass, wind, solar, nuclear, wave, tidal and hydrogen - Sustainability and environmental trade-offs of different energy systems - Possibilities for energy storage or regeneration (e. g. pumped storage hydro power projects, superconductor-based energy storages and high efficiency batteries).

Module 2 Ecosystems

Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem (ponds, streams, lakes, rivers, oceans and estuaries).

Module 3 Biodiversity and its conservation

Introduction - Genetic, species and ecosystem diversity - Bio-geographical classification of India - Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, national and local levels - India as a mega-diversity nation - Hotspots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife and man-wildlife conflicts -

Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Module 4 Environmental pollution

Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides

Module 5 Social issues and the environment

From unsustainable to sustainable development - Urban problems related to energy, water conservation, rain water harvesting and watershed management - Resettlement and rehabilitation of people: its problems and concerns - Case studies - Environmental ethics: issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust - Case studies - Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation - Public awareness.

Textbooks / References

1) M. Abu-orf, G. Tchobanoglous, H. Stensel and R. Tsuchihashi, Wastewater Engineering - Treatment and Resource Recovery, McGraw-Hill Co.
2) Walter R. Niessen, Combustion and Incineration Processes, Applications in Environmental Engineering, Fourth Edition.
3) N. L. Nemerow, F. J. Agardy, J. A. Salvato, Environmental Engineering, Prevention and Response to Water-, Food-, Soil-, and Air-borne Disease and Illness.
4) J. Jeffrey, P. A. Vesilind and R. Weiner, Environmental Pollution and Control.

Course code	**CEC601**				
Category	**Professional Core**				
Course title	**Computer Networks**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**6**
Pre-requisites if any	**-----**				

Module 1

Introductory concepts - Goals and applications of networks - Categories of networks - Organization of the Internet, ISP, network structure and architecture (layering principles, services, protocols and standards) - The OSI reference model - TCP/IP protocol suite - Network devices and components - Physical layer: network topology design, types of connections, transmission media, signal transmission and encoding - Network performance and transmission impairments - Switching techniques and multiplexing.

Module 2

Link layer: framing, error detection and correction, and flow control (elementary data link protocols, and sliding window protocols) - Medium access control and local area networks (LANs): channel allocation, multiple access protocols, LAN standards, link layer switches and bridges (learning bridge and spanning tree algorithms).

Module 3

Network layer: point-to-point networks, logical addressing, basic internetworking (IP, CIDR, ARP, RARP, DHCP, ICMP), routing, forwarding and delivery - Static and dynamic routing - Routing algorithms and protocols - Congestion control algorithms - IPv6.

Module 4

Transport layer: process-to-process delivery, transport layer protocols (UDP and TCP), multiplexing, connection management, flow control and retransmission, window management and TCP congestion control - Quality of service.

Module 5

Application layer: Domain Name System (DNS), World Wide Web (WWW) and Hyper Text Transfer Protocol (HTTP) - Electronic mail - File transfer protocol (FTP) - Remote login - Network management - Data compression - Cryptography: basic concepts.

Textbooks / References

1) B. Forouzan, Data Communication and Networking, McGraw-Hill Co.
2) Andrew Tanenbaum, Computer Networks, Prentice Hall.
3) William Stallings, Data and Computer Communication, Pearson Education.
4) Kurose and Ross, Computer Networking: A Top-Down Approach, Pearson Education.
5) Peterson and Davie, Computer Networks: A Systems Approach, Morgan Kaufmann Publishers.

Course code	**CEC602**				
Category	**Professional Core**				
Course title	**Database Management Systems**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**6**
Pre-requisites if any	**-----**				

Module 1

Overview - Database system vs file system - Database system concepts and architecture - Data model schema and Instances - Data independence and database language and interfaces - Data definitions language, DML and overall database structure - Data modelling using the entity relationship (ER) model: ER model concepts, notation for ER diagram, mapping constraints, keys, concepts of super key, candidate key and primary key - Generalization, aggregation and reduction of an ER diagrams to tables - Extended ER model - Relationship of higher degree.

Module 2

Relational data model and language: relational data model concepts, integrity constraints, entity integrity, referential integrity, keys constraints, domain constraints, relational algebra, relational calculus, tuple and domain calculus - Introduction on SQL: characteristics and advantages of SQL - SQL data type and literals - Types of SQL commands - SQL operators and their procedure - Tables, views and indexes - Queries and subqueries - Aggregate functions - Insert, update and delete operations, joins, unions, intersections, minus, cursors and triggers - Procedures in SQL / PLSQL.

Module 3

Database design and normalization: functional dependencies, normal forms, first, second and third normal forms, BCNF, inclusion dependence, lossless join decompositions, normalization using FD, MVD and JDs - Alternative approaches to database design.

Module 4

Transaction processing concept: transaction system, testing of serializability, serializability of schedules, conflict and view serializable schedule - Recoverability - Recovery from transaction failures - Log-based recovery - Checkpoints - Deadlock handling - Distributed database: distributed data storage, concurrency control and directory system.

Module 5

Concurrency control techniques: concurrency control, locking techniques for concurrency control, time stamping protocols for concurrency control, validation-based protocol, multiple granularity, multi version schemes and recovery with concurrent transaction - Case study of Oracle.

Textbooks / References

1) A. Silberschatz, H. F. Korth and S. Sudarshan, Database Concepts, McGraw Hill Co.
2) C. J. Date, An Introduction to Database Systems, Addison Wesley.
3) R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Pearson Education.
4) Patrick O' Neil, Databases, Elsevier Inc.
5) R. Ramakrishnan, Database Management Systems, McGraw-Hill Education.

Course code	**CEC603**				
Category	**Professional Core**				
Course title	**Automata Theory and Compiler Design**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**6**
Pre-requisites if any	**-----**				

Module 1

Basic concepts and automata theory - Introduction to theory of computation - Automata, computability and complexity - Alphabets - Symbols - Strings - Formal languages - Deterministic Finite Automata (DFA): definition, representation, acceptability of a string and language - Non-deterministic Finite Automata (NFA) - Equivalence of DFA and NFA - NFA with ε-transition - Equivalence of NFAs with and without ε-transition - Finite automata with output - Moore machine, Mealy machine, Equivalence

of Moore and Mealy machines - Minimization of finite automata - Myhill-Nerode theorem - Simulation of DFA and NFA - Regular expressions and languages: regular expressions, transition graph, Kleene's theorem, finite automata and regular expression - Arden’s theorem - Algebraic method using Arden’s theorem - Regular and non-regular languages - Pigeonhole principle - Pumping lemma and its applications.

Module 2

Regular and non-regular grammars: Context Free Grammar (CFG) - Definition, derivations, languages, derivation trees and ambiguity - Regular grammars - Right linear and left linear grammars - Conversion of FA into CFG and regular grammar into FA - Simplification of CFG - Normal forms - Chomsky Normal Form (CNF) and Greibach Normal Form (GNF) - Push down automata and properties of context free languages - Nondeterministic Pushdown Automata (NPDA) - Definition, moves, a language accepted by NPDA - Deterministic Pushdown Automata (DPDA) and Deterministic Context free Languages (DCFL) - Pushdown Automata for Context Free Languages - Context-free grammars for Pushdown Automata - Two stack Pushdown Automata - Pumping Lemma for CFL.

Module 3

Turing machines and recursive function theory: basic Turing machine model, representation of Turing machines, language acceptability of Turing Machines - Techniques for Turing machine construction - Introduction to compiler: phases and passes, bootstrapping, finite state machines and regular expressions and their applications to lexical analysis - Optimization of DFA-based pattern matchers, implementation of lexical analyzers, lexical-analyzer generator, LEX compiler, formal grammars and their application to syntax analysis, BNF notation, ambiguity, and YACC - Syntactic specification of programming languages: context-free grammars, derivation and parse trees, and capabilities of CFG.

Module 4

Basic parsing techniques: parsers, shift reduce parsing, operator precedence parsing, top-down parsing, and predictive parsers - Automatic construction of efficient parsers: LR parsers, the canonical Collection of LR(0) items, constructing SLR parsing tables, constructing Canonical LR parsing tables, and constructing LALR parsing tables - Using ambiguous grammars - An automatic parser generator - Implementation of LR parsing tables - Syntax-directed translation: syntax-directed translation schemes - Implementation of syntax-directed translators - Intermediate code, postfix notation, parse trees and syntax trees, three address code, quadruple and triples, and translation of assignment statements - Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top down parser - More about translation - Array references in arithmetic expressions, procedure call, declarations and case statements.

Module 5

Symbol tables: data structure for symbols tables, representing scope information - Run-time administration: implementation of simple stack allocation scheme, storage allocation in block structured language - Error detection and recovery: lexical phase errors, syntactic phase errors, and semantic errors - Code generation: design Issues, the target Language - Addresses in the target

code, basic blocks, and flow graphs - Optimization of basic blocks and code generator - Code optimization: machine-independent optimizations, loop optimization, DAG representation of basic blocks, value numbers and algebraic laws - Global data-flow analysis.

Textbooks / References

1) J. E. Hopcraft, R. Motwani, and J. Ullman, Introduction to Automata theory, Languages and Computation, 2nd Edition, Pearson Education Asia.
2) J. Martin, Introduction to Languages and the Theory of Computation, 3rd Edition, Tata McGraw-Hill.
3) C Papadimitriou and C. L. Lewis, Elements and Theory of Computation, PHI.
4) Aho, Sethi and Ullman, Compilers: Principles, Techniques and Tools, Pearson Education.
5) K. Muneeswaran, Compiler Design, First Edition, Oxford University Press.

Course code	**CEC604**				
Category	**Professional Core**				
Course title	**Digital Manufacturing I (CAD / CAM)**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**6**
Pre-requisites if any	**-----**				

Module 1

Introduction: introduction to design process and role of computers in product cycle - definition and scope of CAD - graphics input devices - cursor control devices - digitizers - image scanner - graphics display devices - cathode ray tube - random and raster scan display - color CRT monitors - direct view storage tubes - flat panel display - hard copy printers and plotters.

Module 2

Homogenous representation of geometric models - transformation of geometric models: translation, scaling, reflection, and rotation - concatenated transformations - mapping of geometric models: general mapping - translational mapping - rotational mapping - mappings as changes of coordinate system - inverse transformations and mapping.

Module 3

Geometric modelling: analytical and synthetic curves with advantages and disadvantages - comparison with parametric curves - geometric modelling of Hermite cubic spline, Bezier, and B-spline curves - parametric representation of surfaces: plane, ruled, tabulated cylinder, coon patches and surfaces of revolution - solid models: fundamentals of solid modeling - different solid representation schemes: half -spaces - Boundary representation (B-rep) - Constructive Solid Geometry (CSG).

Module 4

Part programming for milling (basic): G codes and M codes - 2-axis programming (milling): absolute and incremental programming - G54 and G92 - 2½-axis programming: G02 and G03 programming - cutter radius compensation programming - Part programming for milling (canned cycles): drilling and boring - cutter length compensation - multiple tools - advanced techniques: do and nested do loops - subroutine - mirror image - polar rotation - pocket milling.

Module 5

Part programming for turning - G and M codes: 2-axis programming (turning) - absolute and incremental programming - program for machining of castings - G90 box turning cycle and taper turning cycle - G94 facing cycle and taper turning cycle - G71 multiple turning cycle - G72 multiple facing cycle - G73 pattern repeating cycle - threading cycles and double start thread - peck drilling cycle - grooving cycle - boring, blend radius and chamfer.

Module 6

APT programming: structure of APT programs - geometric statements - motion commands - processor and post processor - tolerances - freeform curves: cubic splines and Bezier curves - parameterization - introduction to Bezier surfaces - surface interpolation.

Textbooks / References

1) Browne, J. Computer Aided Engineering and Design.
2) Radhakrishnan, P., V. Raju, and S. Subramanyam, CAD / CAM / CIM.
3) Rao, P. N., CAD / CAM Principles and Applications, Tata McGraw-Hill.
4) Rogers and Adams, Mathematical Elements for Computer Graphics.
5) Rooney and Steadman, Principles of Computer Aided Design.
6) Zeid, I., CAD / CAM Theory and Practice.
7) Y. Koren, Computer Control of Manufacturing systems, McGraw Hill (2009).
8) Suh Suk-Hwan, Kang Seong-Kyoon, Chung Dae-Hyuk, Stroud Ian., Theory and Design of CNC Systems, 2008, Springer-Verlag London Limited
9) Smith Peter, CNC programming handbook, 2nd edition, 2003, Industrial Press Inc.
10) Groover, M. P. and Zimmers, E. W., CAD/CAM: Computer Aided Design & Manufacturing, 2006, Pearson Education India.
11) Chang, T. C., R. A. Wysk and H. P. Wang, Computer Aided Manufacturing, Prentice Hall.
12) Groover, M. P., Automation, Production Systems, and Computer Integrated Manufacturing, Prentice Hall India.
13) Seames, W., Computer Numerical Control: Concepts and Programming, Delmar Thomson Learning / Cengage Learning.
14) L. Piegl and W. Tiller, The NURBS Book, Springer-Verlag.
15) Manuals of CAD/CAM Software Package on CAM Module and CNC Machines.

Course code	**HSS701**				
Category	**Humanities and Social Sciences**				
Course title	**Principles of Management**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**7**
Pre-requisites if any	**-----**				

Module 1

Introduction of organizations and management - Concepts of industrial management - Characteristics of Management - Management as an art - profession - Principles of management - The evolution of

management - Organizational environment - Decision-making: types, conditions and decision-making process - Decision making aids.

Module 2

Dimensions of P-O-L-C: vision and mission - Strategizing - Goals and objectives - Organization design - Culture - Human resource management - Understanding work teams - Motivation - Leadership and communication and interpersonal skills - Foundations of control.

Module 3

Introduction to functional areas of management: operations management, marketing management and financial management.

Module 4

Introduction to entrepreneurship - Start-ups: prospects and challenges - Environmental issues - CSR - Sustainability - The role of statistics for industrial management - Simple linear regression and correlation assumptions.

Module 5

Properties of least square estimator - Its application by taking industrial data and its interpretations - Statistical software E-view to be utilized to solve the industrial problems.

Textbooks / References

1) H. Koontz and H. Weihrich, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill, 2015.
2) S. P. Robbins, R. Bergman, I. Stagg and M. Coulter, Management, Prentice Hall, 7th Edition, 2015.
3) Richard I. Levin and David S. Rubin, Statistical management, 7th Edition, Prentice Hall India, 2011.
4) P. Kotler, et al., Marketing Management, 3rd Edition, 2016.
5) Eugene F. Brigham and Michael C. Ehrhardt, Financial Management: Theory and Practice, Southwestern College Pub., 15th Edition, 2016.

Course code	**CEC701**				
Category	**Professional Core**				
Course title	**Digital Manufacturing II (PLM and CAE)**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**7**
Pre-requisites if any	**-----**				

Module 1

Introduction to product lifecycle management (PLM) - Need for PLM - Product lifecycle phases - Opportunities of globalization - Pre-PLM environment - PLM paradigm - Importance and benefits of PLM - Widespread impact of PLM - Focus and application - A PLM project - Starting the PLM initiative - PLM applications - PLM strategies: industrial strategies, strategy elements, its identification, selection and implementation - Developing PLM vision and PLM strategy - Change in management for PLM.

Module 2

Product design and development process - Engineering design, organization and decomposition in product design - Typologies of design process models - Reference model - Product design in the context of the product development process - Relation with the development process planning phase, and relation with the post design planning phase - Methodological evolution in product design - Concurrent engineering - Characteristic features of concurrent engineering - Concurrent engineering and life cycle approach - New product development (NPD) and strategies - Product configuration and variant management - The “Design for X” system: objectives, properties and “Design for X” tools - Choice of “Design for X” tools and their use in the design process.

Module 3

Product data management (PDM): product and product data, PDM systems and importance, components of PDM, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.

Module 4

Virtual product development tools for components, machines, and manufacturing plants - 3D CAD systems and realistic rendering techniques - Collaborative product development - Engineering vaulting, product reuse, smart parts, engineering change management - Bill of materials and process consistency - Digital mock-up and prototype development, design for environment, virtual testing and validation, and marketing collateral - Modelling and simulation in product design: finite element analysis (FEA) to validate functional performance - General stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints…), post-processing, results and verifications - Topology optimization in additive manufacturing - Examples / case studies.

Module 5

Integration of environmental aspects in product design - Sustainable development, design for environment - Need for life cycle environmental strategies - Useful life extension strategies - End-of-life strategies - Introduction of environmental strategies into the design process life cycle - Environmental strategies and considerations for product design.

Module 6

Life cycle assessment and life cycle cost analysis: properties, and framework of life cycle assessment - Phases of LCA in ISO standards - Fields of application and limitations of life cycle assessment - Cost analysis and the life cycle approach - General framework for LCCA - Evolution of models for product life cycle cost analysis.

Textbooks / References

1) Antti Saaksvuori and Anselmi Immonen, Product Lifecycle Management, Springer, 2005.
2) John Stark, Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer.
3) Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006.

4) Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw-Hill Inc., 2015.
5) Parametric Technology Corporation (PTC), Simulation using Creo Parametric user guides.
6) V. Raja and K. J. Fernandes (Eds.), Reverse Engineering: An Industrial Perspective, 1st Ed., Springer-Verlag London, 2008.
7) N. Hopkinson, R. J. M. Hague and P. M. Dickens (Eds.), Rapid Manufacturing: An Industrial Revolution for the Digital Age, Wiley International.
8) S. S. Rao, The Finite Element Method in Engineering, 5th Edition, Butterworth-Heinemann Co.

Course code	**HSS801**				
Category	**Humanities and Social Sciences**				
Course title	**Entrepreneurship**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**8**
Pre-requisites if any	**-----**				

Module 1 Introduction

Meaning and importance - Evolution of term "entrepreneurship" - Factors influencing entrepreneurship: psychological factors, social factors, economic factors and environmental factors - Characteristics of an entrepreneur - Entrepreneur and entrepreneur - Types of entrepreneur: according to type of business, according to use of technology, according to motivation, according to growth, according to stages and new generations of entrepreneurship viz. social entrepreneurship, edupreneurship, health entrepreneurship, tourism entrepreneurship, women entrepreneurship etc. - Barriers to entrepreneurship.

Module 2 Entrepreneurial motivation

Motivation - Maslow's theory - Herzberg's theory - McGregor's Theory - McClelland's need-achievement theory - Culture and society - Values / ethics - Risk taking behaviour.

Module 3 Creativity

Creativity and entrepreneurship - Steps in creativity - Innovation and inventions: using left brain skills to harvest right brain ideas; legal protection of innovation - Skills of an entrepreneur - Decision making and problem-solving steps in decision making.

Module 4 Organisation assistance

Assistance to an entrepreneur - New ventures - Industrial park (meaning, features and examples) - Special economic zone (meaning, features and examples) - Financial assistance by different agencies - MSME act - Small scale industries - Carry on business (COB) licence - Environmental clearance - National Small Industries Corporation (NSIC) - Government stores purchase scheme (e-tender process) - Excise exemptions and concession - Exemption from income tax - Quality standards with special reference to ISO - Financial assistance to MSME - Modernisation assistance to small scale units - The Small Industries Development Bank of India (SIDBI) - The State Small Industries Development Corporation (SSIDC) - Export oriented units: incentives and facilities to exports entrepreneurs, export oriented zone and Export-Import Bank of India - Other agencies for industrial

assistance - State Industrial Development Corporations - State Financial Corporations (SFCs) - Directorate General of Supplies and Disposals (DGS&D): registration with DGS&D, registration categories, registration procedure, benefits of DGS&D and information facilities centre in DGS&D - Khadi and Village Industries Commission (KVIC) - Industrial estates: financing of industrial estates.

Module 5 Rules and legislations

Applicability of legislation - Industries Development (Regulations) Act, 1951 - Factories Act, 1948 - The Industrial Employment (Standing Orders) Act, 1946 - Suspension - Stoppage of work - Termination of employment - Environment (Protection) Act, 1986 - The Sale of Goods Act, 1950 - Industrial Disputes Act, 1947.

Module 6 Project report

Introduction - Idea selection - Selection of the product / service - Aspects of a project - Phases of a project - Project report - Contents of a project report - Proforma of a suggested project report for a manufacturing organization.

Textbooks / References

1) Robert D. Hisrich, M. P. Peters and D. A. Shepherd, Entrepreneurship, McGraw Hill, 10th Edition.
2) Rajeev Roy, Entrepreneurship, Oxford Higher Education, 2nd Edition, 2011.
3) David H. Holt, Entrepreneurship: New Venture Creation, Prentice Hall, 2019.
4) A. Osterwalder and Y. Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers (The Strategyzer series), John Wiley & Sons; 1st Edition, 2010.

Course code	**CEC801**				
Category	**Professional Core**				
Course title	**Cyber Physical Systems**				
Scheme and credits	L	T	P	C	Semester
	3	**0**	**0**	**3**	**8**
Pre-requisites if any	**-----**				

Module 1

Introduction to cyber-physical systems (CPS) - Key features of CPS - Application Domains of CPS - Basic principles of design and validation of CPS - Challenges in CPS.

Module 2

CPS Platform components: CPS hardware platforms, processors, sensors and actuators - CPS networks - wireless, CAN, automotive ethernet - Scheduling real-time CPS tasks: synchronous model and asynchronous model.

Module 3

Synchronous and asynchronous model: reactive components, components properties, components composing - Synchronous designs and circuits - Asynchronous processes and operations - Design primitives in asynchronous process - Coordination protocols in asynchronous process - Leader election - Reliable transmission.

Module 4

Security of cyber-physical systems: introduction to CPS security - Basic techniques in CPS security - Cyber security requirements - Attack models and Countermeasures - Advanced techniques in CPS security.

Module 5

CPS applications: healthcare and medical cyber-physical systems, smart grid and energy cyber-physical systems, WSN based cyber-physical systems and Smart cities.

Textbooks / References

1) E. A. Lee and S. A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach.
2) Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3) Raj Rajkumar, Dionisio de Niz and Mark Klein, Cyber-Physical Systems, Addison-Wesley, 2017.
4) Fei Hu, Cyber-Physical Systems, CRC Press, 2013.