AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. Tech. in ELECTRICAL AND COMPUTER ENGINEERING

(BTC-ELC)

CURRICULUM AND SYLLABI

(2019)

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)

AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Awareness of Future Technology: Develop solutions for future systems using smart technologies.

PSO2: Research and Innovation: Identify engineering challenges, approach using cutting edge research tools and execute innovative solutions.

SEMESTER I

Cat.	Code	Title	Credit
HUM	19ENG111	Technical Communication	3
SCI	19MAT101	Single Variable Calculus	1
SCI	19MAT106	Ordinary Differential Equation	2
SCI	19MAT102	Matrix Algebra	2
ENGG	19CSE100	Problem Solving and Algorithmic Thinking	4
SCI	19PHY101/ 19CHY102	Engineering Physics - A/ Engineering Chemistry - B	3
SCI	19PHY181/ 19CHY182	Engineering Physics Lab - A / Engineering Chemistry Lab - B	1
ENGG	19MEE181	Manufacturing Practice	1
ENGG	19MEE100	Engineering Graphics - CAD	3
HUM	19CUL101	Cultural Education - I	2
		Total	22

SEMESTER II

Cat.	Code	Title	Credit
HUM		Free Elective I**	2
SCI	19MAT111	Multivariable Calculus	2
SCI	19MAT116	Laplace Transform	1
SCI	19PHY101/ 19CHY102	Engineering Physics - A/ Engineering Chemistry - B	3
SCI	19PHY181/ 19CHY182	Engineering Physics Lab - A / Engineering Chemistry Lab - B	1
ENGG	19CSE102	Computer Programming	4
ENGG	19EEE113	Electrical Engineering practice	2
ENGG	19ELC101	Electrical & Electronic Circuits	4
ENGG	19ELC102	Digital Electronics	4
HUM	19CUL111	Cultural Education - II	2
		Total	25

SEMESTER III

Cat.	Code	Title	Credit
ENGG	19ELC204	Electric Machines	4
ENGG	19ELC205	Microelectronic Circuits	4
ENGG	19ELC201	Sensors and Sensor Circuit Design	4
ENGG	19ELC203	Computer Architecture	3
SCI	19MAT214	Fourier Transforms and Complex Analysis	3
ENGG	19ELC206	Operating Systems	3
ENGG	19ELC202	Object Oriented Programming	2
HUM	19AVP201	Amrita Values Program I	1
		TOTAL	24

SEMESTER IV

Cat.	Code	Title	Credit
ENGG	19EEE214	Signals & Systems	4
ENGG	19ELC212	Microcontrollers and Applications	4
ENGG	19EEE211	Control Systems	4
ENGG	19ELC211	Data Structures and Algorithms	4
SCI	19MAT216	Probability and Statistics	3
HUM		Free Elective II**	2
HUM	19SSK211	Soft Skills 1	2
HUM	19AVP211	Amrita Values Program II	1
		TOTAL	24

SEMESTER V

Cat.	Code	Title	Credit
ENGG	19ELC304	Machine Learning	3
ENGG	19ELC301	Real Time Embedded Systems	4
ENGG	19ELC303	Energy Systems	4
ENGG	19ELC302	Embedded Digital Signal Processing	4
ENGG		Professional Elective I*	3
ENGG		Professional Elective II*	3
HUM	19SSK301	Soft Skills II	2
ENGG	19LIV390	[Live In Lab]***	[3]
		TOTAL	23+[3]

SEMESTER VI

Cat.	Code	Title	Credit
ENGG	19ELC313	Power Electronics and Drives	4
ENGG	19ELC312	Data Base Systems and Programming	4
ENGG	19ELC311	Computer Networks and Industrial Communication	4
ENGG		Professional Elective III*	3
ENGG		Professional Elective IV*	3
ENGG	19ELC381	Open Lab	1
HUM	19SSK311	Soft Skills III	2
ENGG	19LIV490	[Live in Lab]***	[3]
	19LAW300	Indian Constitution	P/F
		TOTAL	21+ [3]

SEMESTER VII

Cat.	Code	Title	Credit
ENGG	19ELC401	Theory of Computation and Compiler design	4
ENGG	19ENV300	Environmental Science	P/F
ENGG	19MNG300	Disaster Management	P/F
ENGG		Professional Elective V*	3
ENGG		Professional Elective VI*	3
ENGG		Professional Elective VII*	3
PRJ	19ELC495	Project Phase I	2
		TOTAL	15

SEMESTER VIII

Cat.	Code	Title	Credit
PRJ	19ELC499	Project Phase II	10
		TOTAL	10

Total Credits		164

***Professional Elective -** Electives categorised under Engineering, Science ,Mathematics, Live-in-Labs, and NPTEL Courses . Student can opt for such electives across departments/campuses.Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.

**** Free Electives -** This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam - (International Centre for Spiritual Studies).

***** Live-in-Labs** - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.

PROFESSIONAL ELECTIVES

Power & Energy systems			
Cat.	**Code**	**Title**	**Credit**
ENGG	**19EEE331**	**Smart Grid and IoT**	**3**
ENGG	**19EEE335**	**Power Quality & FACTS**	**3**
ENGG	**19EEE337**	**Power System Management**	**3**
ENGG	**19EEE339**	**Power System Operation Control and Stability**	**3**
ENGG	**19EEE336**	**Power Converters**	**3**
ENGG	**19EEE338**	**Power Plant Instrumentation**	**3**
ENGG	**19EEE332**	**De-regulated power system**	**3**
ENGG	**19EEE341**	**Renewable energy and energy conservation**	**3**
ENGG	**19EEE344**	**Energy storage Systems**	**3**
Cyber Physical Systems and Security			
Cat.	**Code**	**Title**	**Credit**
ENGG	**19CSE331**	**Cryptography**	**3**
ENGG	**19CSE332**	**Information Security**	**3**
ENGG	**19CSE366**	**Cyber Security**	**3**
ENGG	**19CSE469**	**Information Retrieval**	**3**
ENGG	**19CSE470**	**Digital Forensics**	**3**
Electro-Biological Systems			
Cat.	**Code**	**Title**	**Credit**
ENGG	**19EEE430**	**Bio medical systems**	**3**
ENGG	**19EEE439**	**Bio Informatics**	**3**
ENGG	**19EEE451**	**Biological Control Systems**	**3**
ENGG	**19ECE331**	**Bio medical instrumentation**	**3**
Automotive Systems			
Cat.	**Code**	**Title**	**Credit**
ENGG	**19EEE432**	**Vehicular Networks and Communication**	**3**
ENGG	**19EEE433**	**E-mobility Business and Policies**	**3**
ENGG	**19EEE434**	**Automotive Electronics**	**3**
ENGG	**19EEE435**	**Automotive Control Systems**	**3**
ENGG	**19EEE436**	**Vehicle Dynamics and Control**	**3**
ENGG	**19EEE437**	**Electric Vehicle Technology**	**3**
Embedded Systems, Robotics & Artificial Intelligence			

Cat.	Code	Title	Credit
ENGG	19CSE350	Internet of Things	3
ENGG	19CSE363	Artificial Intelligence	3
ENGG	19CSE367	Digital Image Processing	3
ENGG	19EEE352	Digital Control Systems	3
ENGG	19EEE353	Process Control and Instrumentation	3
ENGG	19EEE354	Introduction to Robotics	3
ENGG	19EEE355	Mechatronics	3
ENGG	19EEE358	Advanced Microcontrollers	3
ENGG	19EEE362	Deep Learning for Visual Computing	3
ENGG	19EEE363	Digital system design with FPGA	3
Advanced Computer Technologies			
Cat.	**Code**	**Title**	**Credit**
ENGG	19CSE349	Virtual Reality	3
ENGG	19CSE364	Big Data Analytics	3
ENGG	19CSE447	Cloud computing	3
ENGG	19CSE448	Block Chain	3
ENGG	19CSE449	Mobile applications and development	3
ENGG	19CSE450	Quantum Computing	3
ENGG	19CSE468	Web Technology and Applications	3

GENERAL ELECTIVES			
Cat.	**Code**	**Title**	**Credit**
ENGG	19EEE201	Electromagnetic Theory	3
ENGG	19EEE440	Wireless Sensor Networks	3
ENGG	19EEE442	Opto-electronics & Laser Instrumentation	3
ENGG	19EEE444	Electromagnetic Compatability	3
ENGG	19EEE445	Illumination Engineering	3
ENGG	19EEE449	3D Printing and Design	3
ENGG	19EEE452	Formal Methods	3
ENGG	19EEE453	RF Circuit Design	3
ENGG	19EEE454	Software-Engineering	3
ENGG	19MNG331	Financial Management	3
ENGG	19MAT213	Optimization Techniques	3

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY			
Cat.	**Code**	**Title**	**Credit**
SCI	19CHY243	Computational Chemistry and Molecular Modelling	3
SCI	19CHY236	Electrochemical Energy Systems and Processes	3
SCI	19CHY240	Fuels and Combustion	3
SCI	19CHY232	Green Chemistry and Technology	3
SCI	19CHY239	Instrumental Methods of Analysis	3
SCI	19CHY241	Batteries and Fuel Cells	3
SCI	19CHY242	Corrosion Science	3
PHYSICS			
SCI	19PHY340	Advanced Classical Dynamics	3
SCI	19PHY342	Electrical Engineering Materials	3
SCI	19PHY331	Physics of Lasers and Applications	3
SCI	19PHY341	Concepts of Nanophysics and Nanotechnology	3
SCI	19PHY343	Physics of Semiconductor Devices	3
SCI	19PHY339	Astrophysics	3
Mathematics			
SCI	19MAT341	Statistical Inference	3
SCI	19MAT342	Introduction to Game Theory	3
SCI	19MAT343	Numerical Methods and Optimization	3

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM			
Cat.	**Code**	**Title**	**Credit**
HUM	19MNG331	Financial Management	3
HUM	19MNG332	Supply Chain Management	3
HUM	19MNG333	Marketing Management	3
HUM	19MNG334	Project Management	3
HUM	19MNG335	Enterprise Management	3
HUM	19MNG338	Operations Research	3

HUM	**19MEE401**	**Industrial Engineering**	**3**
HUM	**19MEE346**	**Managerial Statistics**	**3**
HUM	**19MEE347**	**Total Quality Management**	**3**
HUM	**19MEE342**	**Lean Manufacturing**	**3**
HUM	**19CSE358**	**Software Project Management**	**3**
HUM	**19CSE359**	**Financial Engineering**	**3**
HUM	**19CSE360**	**Engineering Economic Analysis**	**3**
HUM	**19MNG331**	**Financial Management**	**3**
HUM	**19CSE362**	**Information Systems**	**3**

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS

Cat.	Code	Title	Credit
HUM	**19CUL230**	**Achieving Excellence in Life - An Indian Perspective**	**2**
HUM	**19CUL231**	**Excellence in Daily Life**	**2**
HUM	**19CUL232**	**Exploring Science and Technology in Ancient India**	**2**
HUM	**19CUL233**	**Yoga Psychology**	**2**
HUM	**19ENG230**	**Business Communication**	**2**
HUM	**19ENG231**	**Indian Thought through English**	**2**
HUM	**19ENG232**	**Insights into Life through English Literature**	**2**
HUM	**19ENG233**	**Technical Communication**	**2**
HUM	**19ENG234**	**Indian Short Stories in English**	**2**
HUM	**19FRE230**	**Proficiency in French Language (Lower)**	**2**
HUM	**19FRE231**	**Proficiency in French Language (Higher)**	**2**
HUM	**19GER230**	**German for Beginners I**	**2**
HUM	**19GER231**	**German for Beginners II**	**2**
HUM	**19GER232**	**Proficiency in German Language (Lower)**	**2**
HUM	**19GER233**	**Proficiency in German Language (Higher)**	**2**
HUM	**19HIN101**	**Hindi I**	**2**
HUM	**19HIN111**	**Hindi II**	**2**

HUM	**19HUM230**	**Emotional Intelligence**	**2**
HUM	**19HUM231**	**Glimpses into the Indian Mind - the Growth of Modern India**	**2**
HUM	**19HUM232**	**Glimpses of Eternal India**	**2**
HUM	**19HUM233**	**Glimpses of Indian Economy and Polity**	**2**
HUM	**19HUM234**	**Health and Lifestyle**	**2**
HUM	**19HUM235**	**Indian Classics for the Twenty-first Century**	**2**
HUM	**19HUM236**	**Introduction to India Studies**	**2**
HUM	**19HUM237**	**Introduction to Sanskrit Language and Literature**	**2**
HUM	**19HUM238**	**National Service Scheme**	**2**
HUM	**19HUM239**	**Psychology for Effective Living**	**2**
HUM	**19HUM240**	**Psychology for Engineers**	**2**
HUM	**19HUM241**	**Science and Society - An Indian Perspective**	**2**
HUM	**19HUM242**	**The Message of Bhagwad Gita**	**2**
HUM	**19HUM243**	**The Message of the Upanishads**	**2**
HUM	**19HUM244**	**Understanding Science of Food and Nutrition**	**2**
HUM	**19JAP230**	**Proficiency in Japanese Language (Lower)**	**2**
HUM	**19JAP2313**	**Proficiency in Japanese Language (Higher)**	**2**
HUM	**19KAN101**	**Kannada I**	**2**
HUM	**19KAN111**	**Kannada II**	**2**
HUM	**19MAL101**	**Malayalam I**	**2**
HUM	**19MAL111**	**Malayalam II**	**2**
HUM	**19SAN101**	**Sanskrit I**	**2**
HUM	**19SAN111**	**Sanskrit II**	**2**
HUM	**19SWK230**	**Corporate Social Responsibility**	**2**
HUM	**19SWK231**	**Workplace Mental Health**	**2**
HUM	**19TAM101**	**Tamil I**	**2**
HUM	**19TAM111**	**Tamil II**	**2**

SYLLABUS

SEMESTER I

19ENG111	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-3-3

Course Objectives

- To introduce the students to the elements of technical style
- To introduce the basic elements of formal correspondence
- To introduce technical paper writing skills and methods of documentation
- To improve oral presentation skills in formal contexts

Course Outcomes

CO1: Understand and use the basic elements of formal correspondence and methods of documentation.
CO2: Learn to edit technical content for grammatical accuracy and appropriate tone and style
CO3: Use the library and Internet recourses for research purposes
CO4: Demonstrate the ability to communicate effectively through group mock-technica presentations and other activities

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2										3				
CO3				1										
CO4									3	3				

Syllabus

Unit 1

Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers
General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2

Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals
Formal Correspondence: Writing formal Letters
Mechanics of Writing: impersonal passive & punctuation
Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation
Reading and listening comprehension of technical documents
Mini Technical project (10 -12 pages)
Technical presentations

References

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
Michael Swan. '' Practical English Usage'', Oxford University Press, 2000

Evaluation Pattern

Assessment	Internal	External
Periodical 1	20	
Periodical 2	20	
Continuous Assessment (Lab) (CAL)	40	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT101	SINGLE VARIABLE CALCULUS	L-T-P-C: 1-0-0-1

Course Objectives

- Understand the various functions and their graphs.
- Understand the basic concept of continuous function and find the extreme values of the continuous functions.
- Understand the definite integral and various integration techniques.

Course Outcomes

CO1: To understand the concepts of single variable calculus.
CO2: To sketch graphs for functions using the concepts of single variable calculus and apply the fundamental theorem of calculus to evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	---	---	---	---	---	---	---	---	---	---		
CO2	1	2	---	---	2	---	---	---	---	---	---	---		

Syllabus

Unit 1
Calculus
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)
Unit 2
Limit and Continuity**:** Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. (2.1, 2.6)
Unit 3
Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).
Unit 4
Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. (5.2 - 5.3, 8.1 – 8.5)
Text Book

Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Reference
'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002

Evaluation pattern

At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19MAT106	ORDINARY DIFFERENTIAL EQUATION	L-T-P-C: 2-0-0-2

Course Objective

- To model mechanical systems using differential equations.
- To analyse and solve ordinary differential equations.
- To understand numerical methods for solving ordinary differential equations.

Course Outcomes

CO1: Understand the basic concepts of differential equations
CO2: Solve the ordinary differential equations using variation of parameters, undetermined coefficients and by numerical technique.
CO3: Understand the formation of modelling problems in ordinary differential equations and apply some standard methods to obtain its solutions.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		2	3									
CO3	1	2	2	3								

Syllabus

Unit 1
Ordinary Differential Equations : Linear Differential Equations and Bernoulli Equation. Modelling Problems: Mixing Problem, Electric Circuits and vibration of strings.
Unit 2
Second Order Differential Equations: Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by Variation of Parameters. System of ODEs, Basic Concepts and Theory, Homogeneous Systems and Non-homogeneous with Constant Coefficients. System of differential equations.
Unit 3
Computational Methods: Euler's methods, Runge-Kutta method.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT102	MATRIX ALGEBRA	L -T-P-C: 2-0-0-2

Course Objectives

- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- Apply various iterative techniques to solve the system of equations.

Course Outcomes

CO1: Understand the notion of eigenvalues and eigenvectors, analyse the possibility of diagonalization and hence compute a diagonal matrix, if possible.
CO2: Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyse the given conic section.
CO3: Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	3	1									
CO3	3		1									

Syllabus

Unit 1

Review: System of linear Equations, linear independence.

Unit 2

Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite

Unit 3

Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.

Unit 4

Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors.

Text Book

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books

Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19CSE100	PROBLEM SOLVING AND ALGORITHMIC THINKING	L -T-P-C: 2-1-3-4

Course Objectives

- This course provides the foundations of computational problem solving.
- The course focuses on principles and methods thereby providing transferable skills to any other domain.
- The course also provides foundation for developing computational perspectives of one's own discipline.

Course Outcomes

CO1: Apply algorithmic thinking to understand, define and solve problems
CO2: Design and implement algorithm(s) for a given problem
CO3: Apply the basic programming constructs for problem solving
CO4: Understand an algorithm by tracing its computational states, identifying bugs and correcting them

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1												
CO2	3	2	3		3			3	3	3				
CO3	2	1												
CO4	1	1	2		2									

Syllabus

Unit 1
Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs.
Unit 2
Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.
Unit 3
Problem solving with algorithms – Searching and Sorting, Evaluating algorithms, modularization, recursion. C for problem solving – Introduction, structure of C programs, data types, data input, output statements, control structures.

Text Book(s)
Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC press; 2014 Mar 27.

Reference(s)
Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.

Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.
Curzon P, McOwan PW. The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker. World Scientific Publishing Company; 2017.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19PHY101	ENGINEERING PHYSICS - A	L-T-P-C: 2- 1- 0- 3

Course Objectives

To enable the student to apply fundamental principles of electromagnetism, optics, modern physics including elements of quantum mechanics and its role in materials with specific focus on engineering applications.

Course Outcomes:

CO1: Understand and apply principles of electrodynamics.
CO2: Understand the elements of optics including phenomena of interference, diffraction and polarization.
CO3: Be exposed to the Einstein's theory of matter-radiation interaction and different types of lasers.
CO4: Be familiar with basic idea of quantum theory and its application to particle in a box and tunneling.
CO5: Acquire knowledge on fundamentals of crystal physics – free electron theory and the concept of energy band and fermi energy

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										
CO 2	3	2										
CO 3	3	2	1									
CO 4	3	2										
CO 5	3	2	1									

Syllabus

Unit I: Electrostatics, Magnetostatics and Electrodynamics (15 hours)
Electric field and electrostatic potential for a charge distribution, divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Biot-Savart law, divergence and curl of static magnetic field, vector potential, Stoke's theorem, Lorentz force, Faraday's law and Lenz's law, Maxwell's equations.

Unit II: Waves and Optics (8 hours)
Huygens' Principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting, Young's double slit experiment, Newton's Rings, Michelson interferometer.
Fraunhofer diffraction from single slit and circular aperture, Rayleigh criterion for limit of resolution and its application to vision, diffraction gratings and their resolving power.
Polarization: Unpolarised, polarized and partially polarized lights, polarization by reflection, double refraction by uniaxial crystals, Polaroid, half wave and quarter wave plates.

Unit III: Lasers (4 hours)
Einstein's theory of matter radiation interaction andAandBcoefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (Ruby, Neodymium), dye lasers.

Unit IV: Quantum Mechanics (10 hours)
De Broglie waves, wave functions, wave equation, Schrodinger wave equation: time dependent and time independent form, operators – Eigen functions and Eigenvalues, uncertainty principle, particle in a finite potential one -dimensional box, tunnelling effect (Qualitative)

Unit V: Introduction to Solids (8 hours)

Crystal systems: Miller indices, crystal planes and directions, packing fraction, Classification of solids: Metals, semiconductors and insulators (qualitative), free electron theory of metals, Fermi level, Density of states, Kronig-Penney model and origin of energy bands.

Text Books:

1. David J Griffiths "Introduction to Electrodynamics", 4th Edition, Pearson, 2015.

2. Ajay Ghatak, "Optics", 6th Edition, McGraw Hill Education India Private Limited, 2017.

3. Eugene Hecht, A R Ganesan, "Optics", 4th Edition, Pearson Education, 2008.

4. Arthur Beiser, ShobhitMahajan, S. RaiChoudhury"Concepts of Modern Physics", McGraw Hill Education India Private Limited, 2017.

5. Charles Kittel, "Introduction to Solid State Physics" 8th Edition, Wiley, 2012.

Reference Books:

1. Halliday, Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley, 2015.

2. John David Jackson, "Classical Electrodynamics", 3rd Edition, Wiley, 2007.

3. F A Jenkins, H E White, "Fundamental of Optics", 4th Edition, McGraw Hill Education India Private Limited, 2017.

4. David J Griffiths, "Introduction to Quantum Mechanics", 2nd Edition, Pearson Education, 2015.

5. *M A Wahab, "Solid State Physics", 3rd Edition, Narosa Publishing House Pvt. Ltd., 2015.*

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19PHY181	ENGINEERING PHYSICS LAB - A	L-T-P-C: 0 -0 -3 -1

Course Objectives

- To introduce experiments for the understanding of physics concepts in the areas of electronics, optics, semiconductors, quantum mechanics and electricity and magnetism.
- To acquire experimental skills in studying electrical properties of metals and semiconductors, optical and quantum phenomena and measurement of magnetic field.

Course Outcomes

CO1: Be able to design and perform experiment to study the electrical property of metals and semiconductors.
CO2: Be able to design, perform experiments on dispersion, interference and diffraction.
CO3: Be able to design, perform experiments to measure magnetic field.
CO4: Perform experiment to study atomic spectrum of H_2 atom and quantum nature of light.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1									-	-
CO2	3	1	1	1									-	-
CO3	3	1	1	1									-	-
CO4	3	1	1	1										

List of Experiments

1. Carey Foster's bridge-finding resistance per unit length of the wire and to find the resistivity of the material of a given wire.
2. Spectrometer-Dispersive power of prism.
3. Radius of curvature of given convex lens by Newton's rings method.
4. Laser- wavelength and particle size determination.
5. Band gap of a semiconductor.
6. Solar cell - efficiency and fill factor of the cell.
7. Verifying the quantum nature of hydrogen atom by measuring the wavelengths of spectral lines in Balmer series
8. Photoelectric Effect-Planck's constant and work function of the given metal.
9. Measurement of the magnetic field of paired coils in a Helmholtz arrangement.

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA-Basic principles of experiment, skill, result analysis and viva.

19CHY102	ENGINEERING CHEMISTRY - B	L-T-P-C: 2-1-

Course Objectives

- The main objective of the course is to impart knowledge on the fundamental concepts of chemistry involved in application of several important engineering materials that are used in the industry/day-to-day life.

Course Outcomes

CO1: To understand the fundamental concepts of chemistry to predict the structure, properties and bonding of Engineering materials**.**

CO2: To understand the principle of electrochemistry/photochemistry and applications of various energy Storage system.

CO3: To be able to understand the crystals structure, defects and free electron theory

CO4: To be able to understand the mechanism and application of conductivity polymer is various electronic devices.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2								2
CO 2	3	3	2	2								2
CO 3	3	3	3	3								2
CO 4	3	3	2	3								2

SYLLABUS

Unit 1

Atomic Structure and Chemical Bonding

Fundamental particles of atom – their mass, charge and location – atomic number and mass number – Schrondinger equation. Significance of ψ and ψ^2 – orbital concept – quantum numbers - electronic configuration. Periodic properties. Formation of cation and anion by electronic concept of oxidation and reduction – theories on bonding- octet, Sidwick and Powell, VSEPR and VBT-MOT. Formation of electrovalent, covalent and coordination compounds. Chemistry of weak interactions – van der Waals force and hydrogen bonding.

Unit 2

Electrochemical energy system

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries – classification – primary, secondary and reserve (thermal) batteries. Characteristics – cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell-Duracell, Li-MnO_2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC

Unit 3

Photochemistry and solar energy

Electromagnetic radiation. Photochemical and thermal reactions. Laws of photochemistry, quantum yield, high and low quantum yield reactions. Jablonski diagram - photophysical and photochemical processes, photosensitization, photo-polymerization and commercial application of photochemistry.

Solar energy - introduction, utilization and conversion, photovoltaic cells – design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

Unit 4

Solid state Chemistry

Crystalline and amorphous solids, isotropy and anisotropy, elements of symmetry in crystal systems indices - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects.

Unit 5

Polymer and composite Materials

Conducting polymers**:** Conducting mechanisms - Electron transport and bipolar polymers. Photoconductive polymers**:** Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer. Thermo sensitive polymers**:** Applications - Mechanical actuators and switches. Photo resists - Types - Chemically amplified photoresists -Applications. Magnetic polymers - structure and Applications. Liquid crystalline polymers**:** Fundamentals and process, liquid crystalline displays – applications. Organic LEDs-their functioning-advantages and disadvantages over conventional LEDs - their commercial uses. Piezo electric materials.

Text Books

Vairam and Ramesh "Engineering Chemistry", Wiley, 2012 Amrita Vishwa Vidyapeetham, Department of Sciences, "Chemistry Fundamentals for Engineers", McGraw Hill Education, 2015.

Reference Books

Jain and Jain, "Engineering Chemistry", DhanpatRai Publishing company, 2015
Puri, Sharma and Patania, " Principles of Physical chemistry", Vishal Publishing Co., 2017.
Atkins, "Physical Chemistry", OUP, Oxford, 2009

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CHY182	ENGINEERING CHEMISTRY LAB - B	L-T-P-C: 0-0-

Course Objective

- The objective of the laboratory sessions is to enable the learners to get hands-on experience on the principles discussed in theory sessions and to understand the applications of these concepts in engineering.

Course Outcomes

CO1: Learn and apply basic techniques used in chemistry laboratory for small/large scale water Analyses / Purification.
CO2: To be able estimate the ions/metal ions present in domestic/industry waste water.
CO3: To utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification\ and Spectroscopy.
CO4: To be able to analyze and gain experimental skill.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2								2
CO 2	3	3	2	2								2
CO 3	3	3	3	3								2
CO 4	3	3	3	3								2

Lab:

1. Estimation of alkalinity in given water samples
2. Adsorption of acetic acid by charcoal
3. Potentiometric titration – acid-base/redox
4. Conductometric titration
5. Estimation of hardness by ion-exchange method
6. Determination of molecular weight of polymer
7. Determination of cell constant and unknown concentration of electrolyte
8. Estimation of tin from stannate solution
9. Separation techniques – TLC, Column chromatography
10. Verification of B-L law by UV-spectrophotometer

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

* CA – Principles of experiment, skill, result analysis and report

19MEE181	MANUFACTURING PRACTICE	L-T-P-C: 0-0-

Course Objectives

- Introduce basic concepts pertaining to product dismantling and assembly.
- Familiarize with basic pneumatic components and design & validate simple pneumatic circuits.
- Familiarize with sheet metal tools and operations.
- Provide hands-on training on welding and soldering.
- Familiarize with plumbing tools and processes.
- Inculcate and apply the principles of 3D printing to build simple geometries.

Course Outcomes

CO1: Interpret the functionality of various components in a product through dismantling and assembly
CO2: Identify various pneumatic and electro-pneumatic components
CO3: Fabricate simple sheet metal objects using concepts of surface development
CO4: Perform metal joining operations using soldering and arc welding
CO5: Make simple plumbing joints for domestic applications
CO6: Build simple geometries using 3D printing tools

CO-PO MAPPING

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1							2	1		1	1		
CO2	2	2	1		1				2	1		1	1	1	
CO3	2	2							2	1		1	1		
CO4	2	1							2	1		1	1		
CO5	2		2		2							1	1	1	
CO6	2	2	1		1				2	1		1	1	1	

Syllabus

Product Workshop
Disassemble the product of sub assembly-Measure various dimensions using measuring instruments-Free hand rough sketch of the assembly and components-Name of the components and indicate the various materials used-Study the functioning of the assembly and parts-Study the assembly and components design for compactness, processing, ease of assembly and disassembly-Assemble the product or subassembly.

Pneumatic and PLC Workshop
Study of pneumatic elements-Study of PLC and programming. Design and simulation of simple circuits using basic pneumatic elements-Design and simulation of simple circuits using electro-pneumatics.

Sheet Metal Workshop

Study of tools and equipment - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.)-Fabrication of components using small shearing and bending machines-Riveting practice.

Welding, Soldering and Plumbing Workshops

Study of tools and equipment - Study of various welding & soldering methods

Arc welding practice - fitting, square butt joint and lap joint - Soldering practice. Plumbing tools – Make a piping joint to a simple piping layout (should include cutting, threading and pipe fixing)

3D-Printing Workshop

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MEE100	ENGINEERING GRAPHICS – CAD	L-T-P-C: 2-0-3-3

Course Objectives

- Familiarize with Bureau of Indian Standards (BIS) for creating engineering drawings
- Train the students on proper dimensioning and construction of simple geometries
- Inculcate with the concept of developing orthographic projections and isometric views using CAD drafting package

Note:

Drawing practice to be carried out using drafting package (Auto-CAD)
First angle projection to be followed

Course Outcomes

CO1: Understand the engineering drawing standards and their usage
CO2: Interpret engineering drawings
CO3: Construct and dimension 2-D geometries using CAD software
CO4: Improve coherent visualization skills
CO5: Inculcate with the concept of developing orthographic projections and isometric views

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	2	3	1	2	3		3	2	2	2
CO2	3	3	3	3		2	3	1	2	3		3	2	2	2
CO3	3	3	3	3	3	2	3	1	2	3		3	2	2	2
CO4	3	3	3	3		2	3	1	2	3		3	2	2	2
CO5	3	3	3	3	3	2	3	1	2	3		3	2	2	2

Syllabus

Unit 1

Basic principles of engineering drawing, Standards and conventions, lettering and types of lines, Introduction to drafting software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional drawing environment. Selection of drawing size and scale. Sketching of 2D simple geomentries, editing and dimensioning of 2D geomentries.

Unit 2

Orthographic Projections: Introduction, planes of projection, projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, Projection of regular solids, Sectioning of solids

Unit 3

Plan and elevation of simple buildings with dimensions

Text Book

BasantAgarwal and C M Agarwal., "Engineering Drawing", 2e, McGraw Hill Education, 2015

Reference Book(s)

Bhat N.D. and Panchal V.M. , " Engineering Drawing Plane and Solid Geometry , 42e, Charoatar Publishing House , 2010James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014
K.R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications
Narayan K.L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL101	CULTURAL EDUCATION – I	L-T-P-C: 2-0-

Course Objective

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education**.**

CO2: Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.

CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices**.**

CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.

CO5: Get guidelines for healthy and happy living from the great spiritual masters

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	2	3				2		
CO2						3	1	3				2		
CO3						3	1	3				2		
CO4						3	3	3				2		
CO5						3	1	3				2		

Syllabus

Unit 1

Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.

Unit 2

Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

Unit 3

Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Text Book

Cultural Education Resource Material Semester-1

Reference Book(s)

The Eternal Truth (A compilation of Amma's teachings on Indian Culture)
Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.
Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9
My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER II

19MAT111	MULTIVARIABLE CALCULUS	L-T-P-C: 2-0-0-2

Course Objective

- To understand parameterisation of curves and to find arc lengths.
- To familiarise with calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

Course Outcomes

CO1: Select suitable parameterization of curves and to find their arc lengths
CO2: Find partial derivatives of multivariable functions and to use the Jacobian in practical problems.
CO3: Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, of Divergence Theorem to Evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	---	---	---	---	---	---	---	---	---	---
CO2	1	2	---	---	2	---	---	---	---	---	---	---
CO3	2	2			3							

Syllabus

Unit 1

Functions of severable variables

Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables.

Unit 2

Vector Differentiation

Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Unit 3

Vector Integration

Line Integral, Line Integrals Independent of Path.
Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

Unit 4

Lab Practice Problems:

Graph of functions of two variables, shifting and scaling of graphs. Vector products. Visualizing different surfaces.

Text Book

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Book(s)

Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT116	LAPLACE TRANSFORM	L-T-P-C: 1-0-0-1

Course Objectives

- Understand the definition Laplace transform and its properties.
- Apply Laplace transform to solve the differential equations.

Course Outcomes:

CO1: To understand the Laplace transform and its properties
CO2: Apply the Laplace transform to solve differential equations.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	---	---	---	---	---	---	---	---	---	---
CO2	1	2	---	---	2	---	---	---	---	---	---	---

Syllabus

Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function, Second Shifting Theorem, Dirac's Delta Function. Differentiation and Integration of Transforms. Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations. (Sections: 6.1 to 6.7)
Lab Practice: Laplace transform for different functions.

Text Book:

1. Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books:

1. 'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
2. Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.

Course Evaluation pattern:

At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19CSE102	COMPUTER PROGRAMMING	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE100 Problem Solving and Algorithmic Thinking

Course Objectives

- This course provides the foundations of programming.
- Apart from the usual mechanics of a typical programming language, the principles and methods will form the main focus of this course.
- Shift from learn to program to programming to learn forms the core of this course.

Course Outcome

CO1: Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program
CO2: Understand and analyze a given program by tracing, identify coding errors and debug them
CO3: Make use of the programming constructs appropriately and effectively while developing computer programs
CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1							1						
CO2	1	1	1					1						
CO3	1	2	2					2						
CO4	2	3	2					3						

Syllabus

Unit 1
Introduction and Review of C language constructs. Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recurivse solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

Unit 2
Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings.

Unit 3
Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

Text Book(s)

Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Reference(s)

Byron Gottfried. Programming With C. Fourth Edition, McGrawHill,; 2018.
Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language. Second Edition, Prentice Hall, 1988.
Eric S. Roberts. Art and Science of C. Addison Wesley; 1995.
Jeri Hanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE113	ELECTRICAL ENGINEERING PRACTICE	L-T-P-C: 1-0-3-2

Course Objectives

To develop practical skill in handling Electrical and Electronic appliances and installations.

Course Outcomes

CO1: Knowledge on electrical safety measures and familiarity with electrical tools, electronic components and their symbols.
CO2: Understanding of operation of electrical and electronic appliances.
CO3: Knowledge of domestic wiring and soldering practice.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3							1	3					
CO2	3							1	3					
CO3	3							1	3					

Syllabus

Electronics: Familiarization of electronic components (passive and active components), Resistor, Inductor and capacitor. Study of measuring instruments (Voltmeter, Ammeter and Multimeter). Verification of OHM's law. Measurement and theoretical Verification of series and parallel combination of resistors and capacitors. Familiarization of CRO and function generator, Rectifier circuits, Soldering and De-soldering practice.

Electrical:
Study on power supply and protective devices, Study on basic electrical tools and electrical accessories, Study on various lighting technologies, Study on house hold appliances: Iron box, Fan, Refrigerator, Air conditioner, Food Mixer/grinder

Domestic wiring practices: Glow an incandescent lamp using SPST switch, glow a fluorescent lamp using SPST switch, operate a fan and an incandescent lamp using two independent SPST switch, Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch, Staircase wiring.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC101	ELECTRICAL & ELECTRONIC CIRCUITS	L-T-P-C: 3-0-3 4

Course Objective: To introduce to analysis of electrical and electronics circuits.

Course Outcome

CO1: Ability to interpret network theorems in electrical circuits
CO2: Ability to formulate circuit equations and compute circuit parameters in AC and DC systems
CO3: Ability to analyze the behaviour of electric circuits under steady state and transient conditions
CO4: Understanding of characteristics of fundamental electronic devices.
CO5: Ability to analyze frequency response of transistor amplifiers using small signal models.
CO6: Ability to interpret electrical and electronic circuit behavior through hardware and simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	3												
CO3	3	3	1											
CO4	3													
CO5	3	3	1											
CO6	3	3	2		3			1	2	1				

Syllabus

Unit 1
Review of circuit elements, fundamental laws, AC representations.

Steady state analysis of DC and AC circuits: Practice of Mesh Current and Node Voltage analysis of circuits with independent and dependent sources. Network Reduction : Source transformation : Network Theorems : Thevenin and Norton's theorems; Superposition theorem, Maximum Power transfer Theorem.

Three phase systems – Three phase 3-wire and 4-wire circuits, balanced and unbalanced, Phasor Diagrams.

Unit 2
Transient Analysis: Time domain analysis of first and second order circuits, Frequency Domain analysis: solutions using Laplace transforms, RLC Resonance, Q-factor and Bandwidth. Coupled circuits – Dot convention analysis. Graph theory, Two-Port Networks

Unit 3

Electronic Elements: Diodes, Applications, BJT - characteristics, Biasing, Applications, small signal operation and models, Frequency response - CE amplifier, Emitter follower, Darlington-pair, Power amplifiers, classification and comparison.

Virual lab platforms / simulation demos can be used for effective classroom teaching.

Lab Practice: Hardware/Simulation experiments in Kirchhoff's laws, Network Theorems, Transients, Resonance, Diode Applications, BJT Characteristics etc.

Text Book(s)

Alexander C K and Sadiku M N O, Fundamentals of electric circuits, 5th ed. New York, McGraw-Hill, 2013.
Adel.S.Sedra, Kenneth.C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2005.

Reference(s)

Nahvi M and Edminister J, Schaum's Outline of Electric Circuits, 5th ed. New York, McGraw-Hill, 2011.
Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
Hayt W, Kemmerly J, and Durbin S, Engineering circuit analysis, 7th ed. Boston, McGrawHill Higher Education, 2007
Van Valkenburg M E, Network Analysis, 3rd ed. New Delhi, Prentice Hall-India, 2011.
Virtual labs, NPTEL Videos, Simulation demos etc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ELC102	DIGITAL ELECTRONICS	L-T-P-C: 3-0-3-4

Course Objective

To acquire the basic knowledge of digital logic to analyze, design and implement combinational and sequential logic circuits and apply it to help societal development.

Course Outcome:

CO1: Understand the basics concepts of digital systems.
CO2: Develop Boolean equations and truth tables for synthesis of logic functions and optimize the same using various minimization methods.
CO3: Analyze logic processes and implement logical operations using combinational logic circuits.
CO4: Synthesis and analysis of synchronous and asynchronous sequential circuits.
CO5: Implement digital circuits through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	3	1	1	-	-	1	2	1	-	-	-	-

Syllabus

Unit 1
Introduction to Digital system Design - Digital Logic, Boolean Algebra, Boolean function minimization, K-Map, Combinational Circuit design, Design of Adder, Subtractor circuits, Design of common digital elements.

Unit 2
Design of complex combinational circuits, Combinational logic problem design, Combinational Logic design, Logic Design with PLA, Synchronous Sequential Circuit Design, Design of Sequential modules, Design of **registers and counter, Finite State Machine design and optimization.**

Unit 3
Programmable Logic Devices, Design of Arithmetic Circuits, Design of Memory Circuits, Algorithmic State Machines Chart, Design of Computer Instruction Set and the CPU, Design of a Micro Programmed CPU.
Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Lab exercises: Verification of Boolean Theorems using basic gates, Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters, sequential circuits, design of a Micro Programmed CPU

Text Book

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

References:

Morris Mano, "Digital Design", Pearson Education, Third Edition, 2006.
Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.
Allen Dewey, "Analysis and Design of Digital Systems with VHDL", PWS Publishing Company, 1999.
John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Third Edition, 2001.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CUL111	CULTURAL EDUCATION – II	L-T-P-C: 2-0-0-2

Course Objective

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

Course Outcome

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad-Gītā* and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3					2		
CO2						1		3				2		
CO3						3	3	3				2		
CO4						3	3	3				2		
CO5						1		1						

Syllabus

Unit 1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

Unit 2
The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit 3
Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

Text Book
Cultural Education Resource Material Semester-2

Reference Book(s)

Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.
The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.
Indian Culture and India's Future. Michel Danino. DK Publications.
The Beautiful Tree. Dharmapal. DK Publications.
India's Rebirth. Sri Aurobindo. Auroville Publications.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER III

19ELC204	ELECTRICAL MACHINES	L-T-P-C: 3-0-3-4

Course Objective

To introduce to fundamental concepts, operation and application of electrical machines.

Course Outcome

CO1: Understanding of basic principles, construction and application of electrical machines.
CO2: Ability to develop equivalent circuit and steady state equations of electrical machines.
CO3: Ability to compute and analyze performance characteristics of electrical machines.
CO4: Ability to validate performance of electrical machines through hardware and simulation

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2	1											
CO4	3	1	1		1			1	2	1				

Syllabus

Unit 1

Basics of electric and magnetic circuits, Principles of electromechanical energy conversion, Basic concepts of rotating machines, DC Machines: Construction and working, Types and Characteristics of DC Generators and Motors, Starting, Speed Control and Braking of DC Motors, Efficiency and Testing, applications.

Unit 2

Transformer: Construction and working, Equivalent Circuit, Transformer Losses, Efficiency and Regulation, Transformer Testing, Autotransformers, Three-phase Transformers, star-star, star-delta connection, Parallel Operation of Transformers, applications.

Induction machines – Construction and working, types, Equivalent Circuit, Losses, Efficiency, testing, starting and speed control, torque slip characteristics, Induction generator, single phase induction motor, applications.

Unit 3

Synchronous machines – Construction and working, generators and motors, types-salient pole and non-salient pole, characteristics, performance evaluation- regulation, efficiency, testing, parallel operation, applications.

Virtual/ Animation: - Faraday's Law and Lenz Law, working principle of DC motor (Animation of elementary model) Armature reaction, DC motor/ Generator working, Mutual Induction principle, transformer working, Concept of rotating magnetic field (RMF), working of induction motor, synchronous motor, and other induction machines

Hardware: - DC Machines- Internal and External Characteristics, Speed control, Swinburn's test, Load test, Transformers: - Transformer OC & SC tests,Sumpner's test, Parallel operation, Load test, Induction Machines- Performance evaluation- Direct and indirect methods, testing, speed control methods, Synchronous Machines- Estimation of Regulation of synchronous generator, testing, Parallel operation.

TEXTBOOK

Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.

REFERENCE(S)

Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited 2002
Albert E. Clayton, "The performance and design of direct current machines", Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1992.
S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.
M.G.Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC205	MICROELECTRONIC CIRCUITS	L-T-P-C: 3-0-3-4

Course Objective

To impart knowledge on the fundamental concepts on the design and development of analog electronic circuits and special integrated circuits for various applications.

Course Outcome

CO1: Understanding the characteristic and principle of operation of MOSFET, feedback amplifiers, Op-Amps and Timer ICs, and, CMOS Logics and IC design concepts.
CO2: Ability to apply the circuit theory concepts to design MOSFET amplifiers, feedback amplifier, Op-Amp application circuits and 555 Timer circuits
CO3: Ability to analyse the performance of MOSFET amplifier, feedback amplifiers, Op-Amp application, active filters and 555 Timer.
CO4: Ability todesign various MOSFET amplifiers, feedback amplifiers, Op-Amp based signal conditioning circuits and 555 timer circuits.
CO5: Ability tovalidate various amplifiers, signal conditioners and timer circuits through simulation and hardware

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	1	1	-	-	-	-	-	-	-	-	-
CO4	3	2	3	1	1	-	-	-	-	-	-	-	1	1
CO5	3	2	3	1	2	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
MOS Field Effect Transistors: Introduction, device structures and physical operations, Biasing, small signal operation and models, MOS Amplifiers, frequency and switching characteristics, CMOS. Overview. Design and performance analysis of CMOS inverter. Logic Gate Circuits. Pass-transistor logic. Dynamic Logic Circuit.
Differential Amplifiers: MOS differential Pair, Introduction to differential amplifier with active load.

Unit 2
IC Design philosophy, Current sources, Current mirrors and Current steering circuits, high frequency response. General Feedback structure. Properties of negative feedback. Four basic feedback topologies. Series-Shunt feedback. Operational amplifiers: Equivalent circuit, voltage transfer curve, MRR - Open loop and closed loop frequency response of op-amps, Circuit stability, Slew rate and its effects in applications.
Applications of Op Amp: DC & AC amplifiers - Summing, Scaling and Averaging amplifiers - voltage to current converter - Current to voltage converter - Integrator, Differentiator. Voltage comparators – ZCD-Schmitt trigger with voltage limiter - Precision rectifier circuits - Peak detector - Sample and Hold circuit.

Unit 3

Active Filters: Frequency response characteristics of major active filters. Oscillators and waveform generators, Voltage controlled oscillators, IC 555 timer, astable and monostable operation. phase-locked loops, and analog multipliers.

Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Experiments on analog Integrated circuits – Hardware or simulation Experiments in MOSFET characteristics and applications, Practical Applications of Opamp like Signal operations, comparators, Schmitt trigger, filters, etc.

TEXTBOOK

Adel.S.Sedra, Kenneth.C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2005.
Ramakant A. Gayakwad, " Op-Amps and Linear Integrated Circuits", Prentice Hall of India, 4th Edition, 2000.

REFERENCES

Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
David A. Bell, "Electronic devices and Circuits", 5th Edition, Oxford University Press India, 2008.
Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edision, Pearson education.
Muhammad H. Rashid,'' Microelectronic Circuits: Analysis & Design'',2nd Edition, Cengage Learning ,2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC201	SENSORS AND SENSOR CIRCUIT DESIGN	L-T-P-C: 3-0-3-4

Course Objective

To provide understanding of operating principles of different sensors and design of sensor circuits.

Course Outcome
CO1: Knowledge on operating principles of different types of sensors.
CO2: Ability to design sensor circuits.
CO3: Learning of analog and digital signal conditioning techniques
CO4: Ability to implement sensor circuits

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	1	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Electrical Sensors: Hall effect sensor, CT, PT. Thermal Sensors: Thermistors, Mechanical Sensors: Displacement-LVDT, Pressure sensors, Flow sensors. Semiconductor Resistance versus Temperature, Thermocouples. Design of temperature indicator using IC sensors, Errors due to resistance drift, affects of Op amp offset voltage drift, offset current drift. Error budgeting. Practical design of 4-20 ma current transmitter for resistance sensors and LVDT sensor.
Unit 2
Instrumentation amplifier. Practical designing of a capacitor measurement circuit. Ratio transformer technique. Differential capacitor measurement. Errors in the capacitance measurement. Phase sensitive detection and use of the same for lockin amplifier design.
Unit 3
Analog and Digital Signal Conditioning - Principles of analog signal conditioning, Signal-Level and Bias Changes, Linearization, Conversions, Filtering and Impedance Matching Concept of Loading. Sensor-to-Frequency Conversion Data-Acquisition Systems: Hardware and Software of Data Aquisition System (DAS) Characteristics of digital data: Digitized Value, Sampled Data Systems, Linearization.
Textbook:
1. "Introduction to Instrumentation and Measurement, 3rd Edition", Authors: Robert B. Northrop, Publisher: CRC – Press – Taylor and Francis Group.

References
Paul Horowitz and Winfield Hill, The Art of Electonics (2 nd Edition), Cambridge University Press, 1992.
Process Control Instrumentation Technology, 6 th Edition", Author: Curtis D. Johnson, Publisher: Prentice Hall International Edition.
"Measurement, Instrumentation, and Sensors Handbook", Author/Chief Editor: John G. Webster., Publisher: CRC – Press – Taylor and Francis Group.
Circuits for Analog System Design (NPTEL) - Prof. M.K. Gunasekaran, IISc Bangalore.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC203	COMPUTER ARCHITECTURE	L-T-P-C: 2-0-3-3

Course Objectives

To introduce the concepts of computer architecture and organization and methods to improve system performance.

Course Outcome

CO1: Understanding on design principles of a computing system
CO2: Familiarize the basics of pipelining technique, design issues and hazards.
CO3: Ability to explain the concepts of memory organization
CO4: Ability to validate the learned concepts through simulation/hardware

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	1	1	3	-	-	-	-	-	-	-	1	1

Syllabus
Unit 1
Introduction and Performance of Computing system, Processor Architecture with example as MIPS & Instruction Set, Single Cycle Datapath Design, Control Hardware, Computer Arithmetic, Floating Point Arithmetic, Role of performance.
Unit 2
Introduction to multicycle at a path, Pipelining Technique – Design Issues, Hazards: Structural Hazards, Data Hazards and Control Hazards, Static Branch Prediction, Dynamic Branch Prediction, Advanced Concepts in pipelining.
Unit 3
Memory Organization - Introduction, Cache Memory Organization, Main Memory & Interleaving, I/O Organization, Modern Processors, Parallel Processing.

TEXTBOOK
Patterson DA, Hennessy JL. Computer Organisation and Design, The Hardware/Software interface (ARM Edition). Fourth Edition, Morgan Kaufmann; 2010.

REFERENCES
Palnitkar S. Verilog HDL: a guide to digital design and synthesis. Second Edition, Pearson Education Asia; 2006.
Hamacher et. al. Computer Organisation. Sixth Edition, McGraw-Hill; 2017.
Hennessy JL, Patterson DA. Computer architecture: a quantitative approach. Fifth Edition, Morgan Kauffmann; 2011.
Hayes JP. Computer Organisation and Architecture. Third Edition, McGraw Hill; 2017.
Stallings W. Computer Organisation and Architecture. Tenth Edition, PHI; 2016.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT214	Fourier Transform and Complex Analysis	L-T-P-C: 2-1-0-3

Course objectives

To understand the concepts of Fourier Series and Fourier transforms and its properties.
Apply the Fourier transform for some singles.
To perform calculus for complex variables.
To understand the residues and pole and evaluate the complete integrations.

Course Outcomes

CO1: Understand the periodic functions and obtain the Fourier series for certain functions.
CO2: Understand the Fourier transform and its properties and apply to some periodic signals.
CO3: Understand and carry out differentiation for complex functions.
CO4: Perform integral calculus in complex variables.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	---	---	---	---	---	---	---	---	---
CO2	1	2	1	---	2	---	---	---	---	---	---	---
CO3	2	1	2		1							
CO4	1	2	---	---	2							

Syllabus

Fourier Series: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals, Fourier integral theorem. Sine and Cosine Integrals.

Fourier Transforms: Sine and Cosine Transforms, Properties, Convolution theorem.

Complex Analysis: Complex Numbers, Complex Plane, Polar Form of Complex Numbers. Powers and Roots, Derivative. Analytic Functions, Cauchy - Riemann Equations, Laplace Equation, Conformal mapping, Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarthims, General Power, Linear Fractional Transformation.

Complex Line Integral, Cauchy Integral Theorem, Cauchy Integral Formula, Derivatives of Analytic Functions.

Power Series, Taylor Series and Maclaurin Series. Laurent Series, Zeros and Singularities, Residues, Cauchy Residue Theorem, Evaluation of Real Integrals using Residue Theorem.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

Reference Book(s)

Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.
J. L. Schiff, The Laplace Transform, Springer, 1999.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC206	OPERATING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective

To introduce the concepts of operating systems and its various services.

Course Outcome

CO1: Understand the architecture and functionalities of operating systems
CO2: Ability to apply various algorithms for process scheduling
CO3: Familiarize concepts of process synchronization and memory management

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	1	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction to Operating Systems: Overview- Types of systems-Computer system operations-Operating systems services-System calls-System structure. Process Management: Process concepts-Process scheduling-operation on process- Interprocess communication-Multi threading models-Threading issues-Thread types-CPU scheduling – scheduling algorithms.
Unit 2
Process Synchronization: Semaphores-Critical regions-Monitors-Deadlocks-Methods of handling deadlocks-Deadlock prevention-Avoidance-Detection and recovery. Storage Management: Memory management-Swapping-Contiguous memory allocation.
Unit 3
Paging-Segmentation-Segmentation with Paging-Virtual memory-Demand paging-page replacement -Thrashing. File Systems: Directory structure-Disk scheduling.

TEXTBOOK
Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Tenth Edition, John Wiley and Sons; 2018.

REFERENCES
Deitel HM, Deitel PJ, Choffnes DR. Operating systems. Third Edition, Prentice Hall; 2004.
Tannenbaum AS. Modern Operating Systems. Fourth Edition, Prentice Hall; 2016.
Stevens WR, Rago SA. Advanced programming in the UNIX environment. Second Edition, Addison-Wesley; 2008.
Nutt G. Operating systems. Third Edition, Addison Wesley; 2009.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC202	OBJECT ORIENTED PROGRAMMING	L-T-P-C: 1-0-3-2

Course Objective

Understand fundamentals of programming such as variables, conditional and iterative execution, methods etc and be aware of principles of software development.

Course Outcomes

CO1: Understand the typical object oriented programming constructs.
CO2: Ability to analyze a given program by tracing, identify coding errors and debug them.
CO3: Ability to apply object oriented programming constructs appropriately and effectively to problems.
CO4: Ability to develop object oriented paradigms for real world problem scenarios through simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	3	-	-	-	-	-	-	-	-	3	2
CO3	3	2	3	3	-	-	-	-	-	-	-	-	3	2
CO4	3	2	3	3	-	-	-	1	2	1	-	-	3	2

Syllabus

Unit 1
Object Oriented Programming concepts- Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- Defining classes in Python – constructors, methods -access specifiers - static members – review of Data Types, Variables, Operators, Control Flow, Arrays in python
Unit 2
Polymorphism-overloading , overriding, Inheritance – constructors in sub classes- the Object class – abstract classes and methods- static, final methods and classes – Interfaces – defining an interface, implementing interface
Unit 3
Exceptions - exception handling. Input / Output Basics – Reading and Writing Console – Reading and Writing Files

Textbook
Python 3 Object-oriented Programming - Second Edition by Dusty Phillips Publisher: Packt Publishing, 2015

Reference(s)
John Guttag, "Introduction to Computation and Programming Using Python: With Application to Understanding Data", Second Edition. MIT Press, 2016
Tony Gaddis, "Starting Out with Python", Pearson, 3rd Edition, 2014.
Kenneth A. Lambert, "Fundamentals of Python: First Programs", Cengage Learning, 2nd Edition, 2018.
Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, 2012.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports

19AVP201	**AMRITA VALUES PROGRAM I**	**1 0 0 1**
19AVP211	**AMRITA VALUES PROGRAM II**	**1 0 0 1**

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Course Outcome

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata

CO2: Enabling students to importance of fighting *adharma* for the welfare of the society through Sabha and Vanaparva.

CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas.

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata
Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads
Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita
Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability
Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems
Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal

tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

TEXT BOOKS/REFERENCES:

1. Rajagopalachari. C, *The Ramayana*

2. Valmiki, *The Ramayana*, Gita Press

SEMESTER VI

19EEE214	SIGNALS AND SYSTEMS	L-T-P-C: 3-0-3 4

Course Objective

To understand various types of signals and systems and analyze their properties using continuous and discrete transforms in time and frequency domain.

Course Outcomes

CO1: Knowledge on classification of signals and systems
CO2: Ability to evaluate LTI output using linear convolution technique.
CO3: Ability to analyze signals and systems in time and frequency domains.
CO4: Ability to evaluate theoretical concepts with simulation and laboratory experiments.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	3	-	-	1	2	-	-	-	-	-

Syllabus

Unit 1
Introduction: Integrated approach for continuous and discrete- time cases.
Signals: Classification of signals, Continuous - Discrete time, Even/Odd signals, Periodic/ Nonperiodic signals, Deterministic/Random signals, Energy/Power signals, Basic operations on signals, Basic (Continuous/Discrete) signals. Systems (Continuous/Discrete): Representation, Classification - Linear/Nonlinear, Causal/Noncausal, Time invariant/Time variant, with/ without memory, BIBO stability, Feedback system, LTI system – Response of LTI system, Convolution, Properties (Continuous/Discrete).

Unit 2
Review of Fourier series and Fourier Transforms-Applications-Case Study, Discrete Time Fourier transform and its properties, Introduction to DFT. Laplace Transform analysis of systems: ROC, Inverse LT, Unilateral LT, Solving differential equation with initial conditions.

Unit 3
Sampling: Sampling theorem, Reconstruction of signal, Aliasing, Sampling of discrete time signals,
z-Transform: Definition, ROC, Inverse z-Transform, Properties, Transform analysis of LTI Systems.
Interrelationship amongst different representation and Transforms.
Virtual Lab Platform/ Simulation demos can be used for effective teaching in classroom.
Lab Practice: Simulation Experiments on the generation of signals- ramp,sine,exponential,etc; Discrete Linear Convolution implementation; Fourier transform and Fourier Series ;Power signal analysis using FT.

Textbook

Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.

Reference(s)

Alan V. Oppenheim, Alan S.Willsky ,S,HamidNawab, "Signals and Systems", Prentice Hall India Private Limited,2nd Edition, 1997.

Michael.J.Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.

Rodger E.Ziemer, William.H.TranterD.Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.

Virtual labs, NPTEL Videos, Simulation demos etc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC212	MICROCONTROLLERS AND APPLICATIONS	L-T-P-C: 3-0-3 4

Course Objective

To acquire the basic knowledge of designing microcontrollers based systems and apply it to implement real world applications.

Course Outcomes

CO1: Understanding of concepts of processors and microcontrollers.
CO2: Ability to programPIC16F877A microcontroller
CO3: Design a Microcontroller based system for various applications.
CO4: Ability to develop PIC16F877A applications through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	2	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	3	-	-	1	2	1	2	1	1	1

Syllabus

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Unit 1
Introduction to micro controllers- Architecture and programming, Register files, Memory Organisation, Tristate-logic,Busses-Memory Address register-Memory addressing-Read and wirte operations, ROM- RAM-PROM-EPROM-E2PROM.

Unit 2
PIC16FXXX architecture, operation, data and program memory organization, special function registers, addressing modes, instruction set. Assembler, assembler directives, simple programs, conditional branching. Subroutines, nested subroutines, interrupts, ISR, priority.

Unit 3
Peripherals: Port configuration, Parallel Slave Port, LED and Keyboard interface, Timers/Counters, WatchDog Timer, ADC, USART, CCP module. Introduction to 8051 micro controller: Architecture, Instruction Set, Interrupts, Ports, Timers.

Text Book(s)
Myke Predko, "Programming and customizing the PIC microcontroller", Tata McGraw Hill Publishing Company Limited, Third Edition, 2008.

Reference(s)
T. R. Padmanabhan, "Introduction to microcontrollers and applications", First Edition, Narosa publishing house private limited, 2007.
PIC Micro mid Range MCU Family Reference Manual - Micro Chip Technology Inc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE211	CONTROL SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective

To introduce to the basics of control system design of LTI systems in time and frequency domains.

Course Outcomes

CO1: Ability to model dynamic systems in time domain and frequency domain.
CO2: Ability to analyze the system behavior in time and frequency domains.
CO3: Ability to evaluate the stability of the control system.
CO4: Ability to design the compensators and controllers for desired response.
CO5: Ability to design control systems using hardware and simulation

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	1	1
CO5	3	3	3	3	3	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Introduction to control systems, Mathematical models of physical systems—state space and transfer function representations. Block diagram, Signal flow graph, Feedback control system characteristics, reduction of parameter variations, control over system dynamics and disturbance signals, Use of software tools to analyze and design of control system, Performance of feedback control systems.

Unit 2
Test input signals, transient and steady state response of second and higher order systems, Performance indices. Concept of Stability, Routh-Hurwitz Stability criterion, Root locus method, concept, procedure, Frequency response analysis, Bode plots, Polar plots.

Unit 3
Stability in the Frequency domain, Nyquist criterion. Introduction to design of feedback systems, Lead-Lag compensation networks, PID controllers, state space representation, Controllability and observability. Control system design case studies - Turbine governor/ Robotic hand/ ship steering, etc. Introduction to intelligent controllers

Lab Practice: Experiments in modelling, design and analysis of controllers using Simulation /Online platforms.

Text Book
Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.

Reference(s)

Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
M. Gopal, "Modern Control System Theory", New Age International, 3rd edition 2014.
Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013.
Nagrath.I.J, Gopal.M, "Control Systems Engineering", New Age Publishers 2017
Klir G. J. and Folger T. A., "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India, 2010.
Bose N. K. and Liang P., "Neural Network Fundamentals with Graphs, Algorithms and Applications", Tata McGraw-Hill, 2006.
Robert Fuller, "Advances in Soft Computing, Introduction to Neuro Fuzzy Systems", Springer, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC211	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-0-3-4

Course Objective

To provide understanding of structure and implementation of the common data structures used in computer science and the concept of analyzing algorithms in terms of asymptotic notation.

Course Outcome

CO1: Understanding of basic data structures.
CO2: Ability to illustrate various operations on data structures.
CO3: Ability to analyze algorithms and check for correctness
CO4: Ability to analyze application problems and formulate solutions using data structure.
CO5: Ability to develop various data structures and algorithms through simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			-	-	-	-	-	-	-	-	-	-
CO2	3	1		-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1		1	-	-	-	-	-	-	-	-	-
CO4	3	1	1		1	-	-	-	-	-	-	-	-	-
CO5	3	1	1		2	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Introduction: Overview of Data Structures – A Philosophy of Data Structures - The Need for Data Structures – Cost and Benefits - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs – Space Bounds, Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List - recursion- linear, binary, and multiple recursions. Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue.

Unit 2
Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps.

Unit 3
Search trees – Binary search tree,– Heap Sort - Divide and Conquer Strategy – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens – Selection – External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

TEXTBOOK(S)

Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Java", Fifth edition, John Wiley publication, 2010.
Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.

REFERENCE(S)
Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Java", John Wiley publication, 2013.
Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT216	PROBABILITY AND STATISTICS	L-T-P-C: 2-1-0-3

Course objectives

The course is expected to enable the students

- To understand discrete and continuous random variables and to compute important measures.
- To carry out various statistical tests and to draw practical inferences.

Course outcomes

CO1: To find out probabilistic measures of discrete and continuous random variables.
CO2: To conduct tests of hypothesis and tests of significance and to arrive at inferences.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1		1	1							2	1	1
CO2	1	1	1		1						1	1	2	1

Syllabus

Probability – Probability models and axioms, conditioning and Bayes' rule
Discrete random variables; probability mass functions; expectations, examples, multiple discrete random variables: joint PMFs, expectations, conditioning, independence
Continuous random variables, probability density functions, expectations, examples, multiple continuous random variables, continuous Bayes rule, covariance and correlation.
Statistics – Bayesian statistical inference, point estimators, parameter estimators, test of hypotheses, tests of significance.

Text book
Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.

Evaluation Pattern

Assessment	Weightage
Test 1 (after 15th lecture hr)	25
*Continues Assessment (CA)	25
Test 2 (after 30th Lecture hr)	50

*CA – Can be Quizzes, Assignments, Projects, and Reports

19SSK211	SOFT SKILLS I	L-T-P-C: 1-0-3-2

Course Outcome

CO 1 - Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO 2 - Soft Skills: Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO 3 - Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO 4 – Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO 5 - Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO 6 – Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4										3		3
CO5										3		3
CO6									3	3		3

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work - environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, Self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quantitative Aptitude by R. S. Aggarwal,S. Chand
Quantitative Aptitude – Abijith Guha, TMH.
Quantitative Aptitude for Cat - Arun Sharma. TMH.

REFERENCES:

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER V

19ELC304	MACHINE LEARNING	L-T-P-C: 3-0-0-3

Course Objectives

To introduce the fundamental concepts of various optimization techniques and machine learning algorithms.

Course Outcome

CO1: Understanding of basic concepts of various optimization techniques.
CO2: Ability to apply supervised and unsupervised machine learning algorithms
CO3: Ability to apply supervised and unsupervised machine learning algorithms

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1		-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction - mathematical optimization, least-squares and linear programming,Convex sets - optimization problemin standard form, convex optimization problems, quasi-convex optimization, linear optimization,quadratic optimization, generalized inequality constraints, Unconstrained minimization- gradient descent method, steepest descent method, Newton's method.

Unit 2
Introduction – Supervised learning – Unsupervised Learning – Linear regression andLinear Classification – Feature selection, Dimensionality Reduction –Support Vector Machines, Hyper parameter tuning regularization –Artificial Neural Networks – Clustering

Unit 3
Applications – Machine Learning applied to 1D, ECG/EEG, time-series, 2D data (images) - Introduction to Deep Learning – Deep Learning Architectures – applications to 3D (videos)

TEXT BOOKS/REFERENCES:
Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.
Pattern Recognition and Machine Learning. Bishop, C. M. Springer (2010).
Introduction to Machine Learning with Python. Mueller, A. C. & Guido, S. O'REILLY' Publishers(2016).
Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms.
Buduma, N. &Locascio, N. O'REILLY' Publishers (2017)

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC301	REAL TIME EMBEDDED SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective

To learn basic concepts of advanced microcontrollers and real time operating systems.

Course Outcome

CO1: Understanding on architecture of embedded computing platforms.
CO2: Ability to program ARM based controllers.
CO3: Exposure on basic concepts of real time operating system.
CO4: Ability to solve real-time applications using embedded-system concepts
CO5: Ability to develop ARM based real time applications through simulation and hardware

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-	1	1
CO5	3	2	2	1	1			1	2	1	-	-	1	1

Syllabus

Unit 1
Introduction to embedded computing and ARM processors - Complex systems and microprocessors– Embedded system design process Instruction sets preliminaries – ARM Processor – CPU: programming input and output-supervisor mode, exceptions and traps – Co-processors- Memory system mechanisms.

Unit 2
Embedded Computing Platform Design-The CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture – platform-level performance analysis – Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

Unit 3
Processes and operating systems- Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real-time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE.

Text book
David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.

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Reference(s)

Marilyn Wolf, "Computers as Components – Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ELC303	ENERGY SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective

To familiarize with the structure, operation and analysis of components in power system network.

Course Outcome

CO1: Understanding of the operations of generation, transmission, distribution systems.
CO2: Ability to model power system networks and components.
CO3: Ability to apply methods of load flow, fault analysis and stability analysis of power system.
CO4: Familiarity with economic operation of power system and power system control.
CO5: Ability to carry out modelling, simulation and performance analysis of power system network.

CO-PO Mapping

PO/PSO / CO	O1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-			-	-	-	-	-	-	-	-		
CO5	3	1	1	-	3	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Structure of Electric Power Systems-Conventional, Deregulated Structure, Grid Structure Micro-grid and Smart Grid Structure; Electric power generation – Conventional sources, Alternate Energy sources, need for interconnected system. Transmission System modelling, Distribution Systems.
Corona, Voltage Regulation, Efficiency, Real and reactive power flow, Power factor correction, Harmonics, Compensation.

Unit 2
Representation of power system: Power system components model, Single line diagram and per unit representation, reactance diagram, impedance diagram.
Analysis of Power Networks in Steady State - Load flow analysis problem formulation, models, solution methods- Gauss seidel, Newton Raphson. Short circuit analysis – symmetrical faults – behavior of short circuit transients in generator and transmission line- unbalanced system.

Unit 3
Power System stability – dynamics of synchronous machine – swing equation – steady state and transient stability – equal area criterion – critical clearing time.
Basic concept of Economic operation of power system, power system operation and control.
Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Lab Practice: Hardware /Simulation/ Coding experiments – Structure of Electric Power System, Power system modeling and performance analysis, load flow analysis, economic operation of power system, load frequency dynamics, power system transients, fault analysis, stability analysis etc.

Text Book

John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, 2016.

Reference(s)

Hadi Saadat,"Power system analysis", McGraw Hill publishing company,2003
B.R.Gupta,"Power system analysis and design",S.Chand & Company Ltd.,2004.
Wadhwa C L 'Electric Power System', Wiley Eastern Limited, India 2007
L.L.Grigsby,"Electrical power engineering Handbook",IEEE press,2001.
Kothari, D. P and Nagrath I J., 'Modern Power System Analysis' Tata McGraw Hill Publishing Company, 2003
Abhijith Chakrabarti, D.P.Kothari and A.K Mukhopadhyay, "An Introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems", PHI learning private limited, India, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ELC302	EMBEDDED DIGITAL SIGNAL PROCESSING	L-T-P-C: 3-0-3-4

Course Objective

To learn the digital signal processing techniques and familiarize computational aspects of DSP algorithms.

Course Outcome

CO1: Understanding on frequency analysis of signals in discrete domain
CO2: Ability to apply FFT for frequency analysis of signals in discrete domain.
CO3: Ability to design, analyze and build digital filters.
CO4: Exposure to constraints & solutions in DSP programming & real-time implementation.
CO5: Skill in programming DSP algorithms and digital filers on hardware platform.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1		-	-	-	-	-	-	-	-	-	
CO5	3	2	2	1	3	-	-	1	2	1	-	-	2	2

Syllabus

Unit 1
Introduction to DSP, DFT, FFT, aliasing and folding, Fixed point representation, Quantization Errors, Overflow and Solutions - Saturation Arithmetic, Overflow Handling, Scaling of signals.

Unit 2
FIR, IIR filter design Software implementation and quantization affect, applications, Computational issues and finite precision affects.

Unit 3
Introduction to Real -time Digital signal processing - Basic elements of Embedded DSP systems, Input signal conditioning, A/D conversion, Sampling, Quantizing and encoding, D/A conversion. DSP hardware options - Fixed- and floating-point Devices, Real-Time constraints.

Textbook(s)

John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.
Sen M Kuo, Bob H Lee."Real Time Digital Signal Processing - Implementations, Applications and Experiments with TMS320C55x." First Edition, 2001.

Reference(s)

Rulph Chassaing, Donald Reay,"Digital Signal Processing and Applications with TMS320Cxxx", Second Edition.2012.
Digital Signal Processing - NPTEL Prof. T.K. Basu IIT Kharagpur.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK301	SOFT SKILLS II	L-T-P-C: 1-0-3-2

Course Outcomes

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

CO # 2 - Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

CO # 3 - Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

CO # 4 – Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

CO # 5 - Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

CO # 6 – Verbal At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

Syllabus

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.

Quick Maths – Tyra.
Quicker Arithmetic – Ashish Aggarwal
Test of reasoning for competitive examinations by Thorpe.E. TMH
Non-verbal reasoning by R. S. Aggarwal, S. Chand

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV390	LIVE-IN-LAB I	L-T-P-C: 0-0-0-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

SEMESTER VI

19ELC313	POWER ELECTRONICS AND DRIVES	L-T-P-C: 3-0-3-4

Course objective

To impart knowledge on the characteristics of power semiconductor devices, operation of different power conversion circuits for various applications and development of electrical drives.

Course Outcome

CO1: Understanding of the characteristics of power semiconductor devices, principles of operation of power converters and control schemes of AC and DC drives.
CO2: Ability to analyze the behavior of power converters under different modes.
CO3: Ability to evaluate the performance of power semiconductor devices, converters and control schemes of electric drives.
CO4: Ability to design power converters and their PWM controls, closed loop control schemes of DC and AC motors.
CO5: Ability to validate the power converter operations and AC & DC motor control schemes using simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	-	-	-
CO4	3	2	3	-	2	-	-	-	-	-	-	-	-	1
CO5	3	2	2	1	3	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Power semiconductor Switches: SCR, BJT, MOSFET, IGBT, safe operating Limits, selection of devices for various applications. AC to DC converters: Single phase and three phase thyristor full bridge rectifier, Single phase PWM rectifiers, control scheme of PWM rectifiers, applications of PWM rectifiers.
DC to DC converters: Concept of dc to dc converter system, PWM duty ratio control, Buck, Boost, Buck-Boost, Cuk converters – Half bridge and full bridge converters.

Unit 2
DC to AC converters: Basic concepts of VSI, operation of single phase half bridge, full bridge and three phase bridge inverters, Current source inverters, comparison of VSI and CSI, PWM modulation strategies: Single phase Sinusoidal PWM (unipolar, bipolar).

Unit 3
Review of speed – torque characteristics of DC motors - methods of speed control - Single phase and three phase converter configurations for various modes of operation of series and separately excited dc motors - chopper controlled dc drives - Speed controlled drive system - Armature current reversal and Field current reversal schemes.

Unit 4

Torque speed characteristics of induction machine - phase controlled induction motor drives - Speed reversal - Four quadrant control – Variable frequency operation of three phase induction machine, voltage fed inverter control and current fed inverter control, Vector control of induction machine, vector control of current fed inverter drive. Wound Rotor Induction Motor Control: Static rotor resistance control. Synchronous Motor Drives: V/f control.

Simulation/ Hardware experiments in characteristics of Power Semiconductor Switches, Power Converters and their control, DC motor divers, Induction motor drives etc.

Text book

Muhammed H Rashid, " Power Electronics- circuits, devices and applications" Pearson Education; Fourth edition 2017.

Reference(s)

Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics: Converters, Applications and Design", Third Edition, John Wiley & Sons, 2007.
L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
Erickson, Maksimovic, and Dragan "Fundamentals of Power Electronics", Kluwer academic publishers, 2001.
Joseph Vithayathil "Power Electronics" Tata McGraw Hill, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ELC312	DATABASE SYSTEMS AND PROGRAMMING	L-T-P-C: 3-0-3-4

Course Objective

To learn fundamentals of different database management systems and understand how to connect to database using python.

Course Outcome

CO1: To introduce to basic relational database concepts, SQL syntax and practical details
CO2: Familiarize specifics of the SQlite and RDBS data management systems
CO3: Ability to build dynamic database-driven apps in Python
CO4: Ability to access python libraries within DBMS
CO5: Ability to validate database management concepts through programming

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	3	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	3	-	-	-	-	-	-	-	2	2
CO4	3	3	-	3	3	-	-	-	-	-	-	-	-	2
CO5	3	3	1	1	3			1	2	1			1	1

Syllabus

Unit 1
Introduction: Overview of DBMS, File vs. DBMS, elements of DBMS. Database design: E-R model, Notations, constraints, cardinality and participation constraints, ER design issues, Weak and strong entity sets, Extended ER features. Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models.

Unit 2
Relational Database Design: Functional dependency, Reduction of ER model to Relational model, Normalization: 1NF, 1NF, 2NF, 3NF. Decomposition Using Functional Dependencies including establishing keys and relationships. SQL: Various DDLs, DMLs, DCLs.

Unit 3
Python and databases: Development tools, drivers, and modules, Design a database within RDBMS and SQLite. Database connectivity with python. CRUD statements using python programming language. Python wrappers within RDBMS.

Text Book
Silberschatz A, Korth H F and Sudharshan S, "Database System Concepts", Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.

Reference(s)

Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Second edition, 2011.
Elmasri R and Navathe S B, "Fundamentals of Database Systems", Fifth Edition, Addison Wesley, 2006.
Ramakrishnan R and Gehrke J, "Database Management Systems", Third Edition, McGraw-Hill, 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC311 COMPUTER NETWORKS AND INDUSTRIAL COMMUNICATION L-T-P-C: 3-0-3-4

Course Objective

To introduce the basic concepts of computer networks and familiarize with industry standard communication networks.

Course Outcome

CO1: To introduce the basics of computer networks and layered approach of network design.
CO2: To familiarize protocol layers and services.
CO3: Ability to analyze routing algorithms, congestion control in the network layer and various encryption algorithms.
CO4: Ability to develop comprehensive understanding of the industrial data communication systems
CO5: Ability to demonstrate various network concepts through simulation and hardware

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	-	-	1	-
CO2	3	2	3	-	3	-	-	-	-	-	-	-	1	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO5	3	2	2	1	3			1	2	1			1	1

Syllabus

Unit 1
Components of data communication, Reference model - Open System Interconnection (OSI), Transmission Control Protocol/ Internet Protocol (TCP/IP) and comparisons, Protocol Layers and Services- The **physical layer**: Theoretical basis for data communication- signaling and modulation-multiplexing-Transmission media. **Data Link Layer:** Error detection and correction, Framing, Flow control, Medium access sub layer-ALOHA Protocols, Carrier Sense Multiple Access Protocols (CSMA), CSMA with Collision Detection, CSMA with collision avoidance, Collision free protocols.

Unit 2
Network Layer: Routing algorithms - shortest path, flooding, Distance Vector Routing, Dijkstra's algorithm, hierarchical, broadcast, multicast, IP protocol - IP address and classifications. Address resolution.**Transport Layer:** Connection Management in TCP, UDP, Congestion control algorithms - leaky bucket, token bucket, load shedding. **Application layer:** security, symmetric encryption-AES, DES, stream cipher, asymmetric encryption, application layer protocols-HTTP, FTS, SMTP.

Unit 3

Introduction to industrial networks – SCADA networks-SCADA Hardware and Software, Remote Terminal unit (RTU), SCADA Master, SCADA/HMI Systems, Communication Architecture, Industrial Wired and Wireless Networks. IEEE 802.3, IEEE 802.11 standards.

Text Book(s)

Tanenbaum A S, "Computer Networks", Fifth Edition, PHI, 2012.
Richard Zurawski, The industrial communication technology handbook, CRC Press, 2005.

Reference(s)

Forouzan B A, "Data Communication and Networking", Fourth Edition, Tata McGraw Hill,2014.
Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004.
Raimond Pigan, Mark Metter, Automating with PROFINET: Industrial Communication Based on Industrial Ethernet, Publicis Publishing 2008.
Stallings W, "Data and Computer Communications", Eight Edition, Pearson Education Asia, 2010.
Kurose J F and Ross K W, "Computer Networking: A Top-Down Approach", Sixth Edition, Pearson Press, 2013.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC381	OPEN LAB	L-T-P-C: 0-0-3-1

Course Objective

To empower with project management skills and develop ability to work in team. To introduce to advanced tools and procedures for technical writing and publications**.**

Course Outcome

CO1: Ability to develop an application by the acquired knowledge in core subjects
CO2: Ability to manage the time and cost of the product development
CO3: Ability to present the work in oral and written mode with proper clarity and justification
CO4: Ability to work as a team and effectively utilize the advanced tools.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	-	-	-	2	-	3
CO2	-	-	-	-	-	-	-	1	-	-	3	2	-	-
CO3	-	-	-	-	-	-	-	1	-	3	-	2	-	-
CO4	-	-	-	-	3	-	-	1	2	-	-	2	3	3

Syllabus

This is a hands-on section for the students. By the sixth semester, the students are adept in different core streams like Power Electronics, Power Systems, Electrical Machines, Energy Systems and Digital Signal Processing etc. The students will apply their acquired knowledge and develop an application related to one or more of the core areas and implement a pragmatic setup, justifying the application.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19SSK311	SOFT SKILLS III	L-T-P-C: 1-0-3-2

Course Outcomes:

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO # 2 - Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO # 3 - Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

CO # 4 – Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

CO # 5 - Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

CO # 6 – Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation / knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics).

Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Data Interpretation by R. S. Aggarwal, S. Chand
Logical Reasoning and Data Interpretation – Niskit K Sinkha
Puzzles – Shakuntala Devi
Puzzles – George J. Summers.

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3
CO5			1						3	3		

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation Presentation Round 1	**2**
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**10**

SEMESTER VII

19ELC401	THEORY OF COMPUTATION AND COMPILER DESIGN	L-T-P-C: 3-1-0-4

Course Objective

To introduce to the mathematical foundations of computations

Course Outcome
CO1: Ability to design various finite state machines and Turing machines
CO2: Ability to demonstrate the push down automata model for a given language.
CO3: Ability to apply algorithms for analyzing lexemes and structural correctness of source programs.
CO4: Ability to experiment intermediate representation and procedure calls.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	1	-	-	-	-	-	-	-	-	-
CO3	2	3	3	1	1	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Automata and Languages: Chomsky hierarchy of languages - Introduction to finite state Automata- Regular Expressions - Nondeterministic Finite Automata - equivalence of NFAs and DFAs –Minimization of DFA. Lexical Analysis.

Unit 2
Non-Regular Languages -Context free languages - Context Free Grammar -Chomsky normal form - Push Down Automata –parse tree derivations- Ambiguous grammar, removing ambiguity. Top down and bottom up parser-LR(0), LR(1), LALR

Unit 3
Turing Machines - Non-deterministic Turing Machines –intermediate representation –procedure calls

Text book(s)
Linz P. An introduction to formal languages and automata. Sixth edition, Jones and Bartlett Publishers; 2016.
Aho, Alfred V., Monica S. Lam, Ravi Sethi, and Jeffrey Ullman, Compilers: Principles, Techniques and Tools, Prentice Hall, Second Edition, 2006.

References(s)

Michael Sipzer, "Introduction to the Theory of Computation", Second Edition, Boston, MA: Course Technology, 2005 (pumping lemma to be followed from this book).
Martin and John, "Introduction to Languages and the Theory of Computation", New York, NY: McGraw Hill, 2002.
J E Hopcroft, R Motwani and J D. Ullman, "Introduction to Automata Theory, Languages, and Computation", Third Edition, Addison-Wesley, 2007.
Cooper, Keith, and Linda Torczon, Engineering a Compiler, Second Edition, Morgan Kaufman, 2011.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC495	PROJECT PHASE I	L-T-P-C: 0-0-6-2

Course Objective

To comprehend, design, develop, implement and test the functionality of a project work and prepare a technical paper in an approved format and present it.

Course Outcome

CO1: Ability to investigate an engineering problem and design/develop the proof of concept of its solution
CO2: Ability to estimate and manage the cost and time of the project
CO3: Ability to present the project with clarity and ethics in both oral and written mode
CO4: Ability to develop a team and effectively participate in the team to execute the project
CO5: Ability to support the environmental, social and engineering discipline through the project

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	3
CO3	-	-	-	-	-	-	-	3	3	3	-	3	3	3
CO4	-	-	-	-	-	-	-	3	3	-	-	-	3	3
CO5	-	-	-	-	3	3	3	3	3	-	-	3	3	3

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports

SEMESTER VIII

19ELC499	PROJECT PHASE II	L-T-P-C: 0-0-30-10

Course Objectives

The project shall be focused on the synthesis of the knowledge gained over the past seven semesters, by taking up a work of relevance to Electrical & Electronics Engineering covering design/development/realization/application/performance analysis/state-of-the-art technology.

Course Outcome

CO1: Ability to investigate on an engineering problem and suggest the proof of concept of its solution
CO2: Ability to estimate and manage the cost and time of the project
CO3: Ability to present the project with clarity and ethics in both oral and written mode
CO4: Ability to develop a team and effectively participate in the team to execute the project
CO5: Ability to support the environmental, social and engineering discipline through the project

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	3
CO3	-	-	-	-	-	-	-	3	3	3	-	3	3	3
CO4	-	-	-	-	-	-	-	3	3	-	-	-	3	3
CO5	-	-	-	-	3	3	3	3	3	-	-	3	3	3

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PROFESSIONAL ELECTIVES

Power & Energy systems

19EEE331	SMART GRID AND IoT	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective: To understand and evaluate Smart Grid technologies.

Course Outcome

CO1: Understanding on fundamental concepts and challenges in smart grid
CO2: Familiarity with various smart grid technologies.
CO3: Exposure on standards and protocols for smart grid.
CO4: Knowledge on IoT applications and computational intelligence in smart grid

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	3	1	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Smart Grid: Comparison with existing grid, Concept of smart grid- Definition, Features, Applications, International policies, Opportunities & Barriers. Smart grid Architecture;

Unit 2
Smart grid Technologies Overview: Communication Technology- LAN, HAN, WAN , interoperability and Scalability; Advanced metering infrastructure (AMI), Energy Management System- SCADA, Wide area measurement systems (WAMS), Distributed energy resources (DERs), Energy Storage, Renewable Energy Integration, Electric Vehicle integration ; Demand Side management ; Smart grid: Protocols and Standards

Unit 3

IoT in Smart grid: IoT Architecture; IoT Messaging Protocols - MQTT, CoAP, AMQP, and DDS; IoT Hardware and Software; Data Analytics in the Smart Grid- Definition, Benefits, Tools, Challenges; need of artificial intelligence and machine learning for Smart grid applications, Standards for Information Exchange - Data Security methods; Introduction to cloud computing, edge computing, Multi-agent technology in Smart grid, Embedded web servers, Protocols for internet connectivity and interoperability, IPV6 and IPV4 protocols for internet connectivity. Case study in smart grid.

Text books/ References

Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Wiley & Sons, IEEE Press, 2011.
James Momoh, "Smart Grid - Fundamentals of Design and Analysis", John Wiley & Sons, IEEE Press, 2012.
Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyam, Nick Jenkins, "Smart Grid Technology and Applications" John Wiley & Sons, 2012.
Clark W. and Gellings P. E., "The Smart Grid: Enabling Energy Efficiency and Demand Response", The Fairmont Press, Taylor & Francis, 2009.
IEEE Internet of Things Journal.
IEEE Power and Energy magazines.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE335	POWER QUALITY & FACTS	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective

To impart knowledge on different power quality issues, causes and mitigation techniques and to select suitable compensators for enhancement of power transfer capability and power quality**.**

Course Outcome

CO1: Understanding of causes and effects of power quality issues, and methods of compensation.
CO2: Exposure to international power quality standards and measuring techniques.
CO3: Ability to apply control schemes for various compensators.
CO4: Ability to analyse performance of conventional and FACTS devices for active and reactive power control and harmonic reduction.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-		-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	3	1		1	-	-	-	-	-	-	-	-	-
CO4	3	3	1		1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Review of power quality issues, definitions and standards, causes and effects of power quality issues, measurements. Harmonic studies: Fourier analysis, FFT Analysis. Improvement techniques: Conventional compensators, Passive and active compensators, shunt/series.

Unit 2
FACTS compensators: Shunt compensators: Passive/ variable impedance type Active/switched converter type. Series compensators: Passive/ variable impedance type. Active/switched converter type. Hybrid compensators. Harmonic Filters: Passive filters, tuned filters, design problems, Active filters-shunt, series, hybrid. Applications and Design problems. Estimation of rate/cost reduction due to hybrid filters.

Unit 3
Active filter control schemes/algorithms: Time-domain and Frequency-domain algorithms, AI based control algorithms, analog/digital implementation & Case studies. Review of improved power quality converters and applications. Custom power parks concept: Custom power devices and applications. Lab Experiments: Simulation and Hardware experiments in Conventional/FACTS/Harmonic compensators and controllers.

Text Books/ References

J.Arillaga, N.R.Watson and S.Chen, "Power System Quality Assessment", John Wiley & Sons, England, 2000.

Math J.Bollen, "Understanding Power Quality Problems-Voltage Sags and Interruptions", John Wiley & Sons, New Jersey, 2000.

Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "Power Quality: Problems and mitigation Techniques", Wiley 2015.

Enrique Acha and Manuel Madrigal,"Power Systems Harmonics-Computer Modeling and Analysis", John Wiley and Sons Ltd., 2001.

George J. Wakileh, "Power Systems Harmonics-Fundamentals, Analysis and Filter Design", Springer-Verlag, New York, 2001.

Selected Publications on Power Quality Improvement.

Ewald F. Fuchs and Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines", 1st edition, Elsevier Academic Press, San Diego, USA, 2008, ISBN: 978-0-12-369536-9.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE337	POWER SYSTEM MANAGEMENT	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objectives

To expose to energy management techniques, forecasting &economic aspects of power supply.

Course Outcomes

CO1: Exposure to Electricity Acts, regulations, business models and power supply reforms.
CO2: Ability to develop models for demand forecasting, energy storage, power pooling and trading
CO3: Ability to apply various power system management techniques and micro economics in power supply systems.
CO4: Familiarity with energy management, reactive power management and energy audit.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-		-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-		-	-	-	-	-	-	-		
CO4	3	2	-	-	-	-	-	-	-	-	-	-		

Syllabus

Unit 1
Introduction: Energy security, Future of electricity, Electricity Acts and Regulations, Demand Forecasting: Forecasting techniques and forecasting modelling. Utility Planning: Generation mix, Conventional and non-conventional generation, Cogeneration, wheeling and banking, Power pooling and trading, Energy storage schemes. Concepts of Smart Grid.

Unit 2
Power System Economics: Time value of money, Methods of depreciation, Payback Calculation, Cost-benefit analysis, Internal rate of return, Net present value, Life cycle coating. Power Supply Reliability: Power system reliability indices, reliability evaluation.

Unit 3
Energy Management: Supply Side Management – issues and remedial measures. Demand Side Management. Operation Planning: Operation and maintenance, reactive power management, Energy Audit.

Text books / References

Pabla. A. S., "Electrical Power System Planning", Macmillan India Ltd, 1998.
Wood A. J. and Wollenberg B. F., "Power Generation, Operation and Control", Wiley Interscience, 1996.
Stoll H. G., "Least Cost Electric Utility Planning", Wiley Interscience, 1996.
Khan E., "Electrical Utility Planning and regulation", American Council for Energy Efficient Economy, Washington DC, 1968.
Heinz Weihrich, Harold Koontz, "Management – A Global Perspective", Tenth Edition, Tata McGraw Hill, 2001.
M. Shahidehpour and M. Alomoush, "Restructured Electric Power Systems – Operations , Trading and Volatility", CRC Press, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE339	POWER SYSTEMS OPERATION, CONTROL & STABILITY	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective:

To provide an insight into the relevance and possibilities of economic operation, control and stability aspects of power system.

Course Outcomes

CO1: Understanding of the principles of power system operation, control and stability.
CO2: Ability to develop mathematical model of power system controls.
CO3: Ability to carry out economic load dispatch and power system stability studies
CO4: Ability to design power system controllers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	1	-	-	-	-	-	-	-		
CO3	3	2	1	1	1	-	-	-	-	-	-	-		
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Power system operation – state transition and control, SCADA in power systems-data acquisition, state estimation, security assessment and security enhancement – functions of control centers, - system load variations – system load characteristics
Economic load dispatch with and without losses – solution by iteration method (no derivation of loss coefficient) – Base point and participation factor. Real and Reactive power flows and control.

Unit 2
Basic P-f and Q-V loops, Load frequency control- modeling, analysis and control of single and multi-area – tie line with frequency bias control. Economic controller added to LFC. Need for Automatic Voltage regulator – various excitation systems-Modeling – static and dynamic analysis – Reactive power-voltage control devices.

Unit 3
Power System stability – classifications – Rotor angle stability – small signal stability – Effects of excitation system – Power system stabilizer – sub synchronous oscillations – Voltage stability – Voltage collapse – Methods to improve stability.

Text Book(s)

Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing company, 2004.
Prabha Kundur, "Power System stability and control", Tata McGraw Hill, 2008.

Reference(s)

Kothari, D. P. and Nagrath, I.J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2011.
Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, 1996.
L.K. Kirchmayer, "Economic operation of Power System", John Wiley & Sons, 1967.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE336	POWER CONVERTERS	L-T-P-C: 3-0-0-3

Prerequisite: Power Electronics and Drives

Course Objective

To introduce the concepts and design of converters, feedback controllers, protection circuits, driver circuits and magnetic elements for switched mode power supply applications.

Course Outcome

CO1: Understanding of the principles of steady state and dynamic operation of isolated and non-isolated converters and various control techniques of power supplies.
CO2: Ability to analyze operation of isolated and non-isolated switch mode converters and resonant converter.
CO3: Ability to evaluate the performance of isolated and non-isolated switch mode converters and control schemes, and, resonant converters.
CO4: Ability to design converters, controller, protection, driver circuits and high frequency magnetic elements for SMPS.
CO5: Ability to validate isolated and non-isolated switch mode converters, various control schemes, protection, driver circuits and high frequency magnetic elements for SMPS using simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
CO4	3	1	3	1	1	-	-	-	-	-	-	-	1	1
CO5	3	1	2	2	2	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
DC-DC Switched Mode Converters: Operating principles, Steady state analysis for continuous and discontinuous current operations, Performance calculations of Boost converter, Buck-boost converter, Cuk converter, SEPIC and Interleaved Converters, Comparison of DC-DC converters.

Unit 2
Switched Mode DC Power Supplies: Overview of linear and switched mode power supplies, Isolated converters: Flyback converter, Forward converter, Push pull converter, Half bridge converter & Full bridge converter.

Unit 3
Design of snubbers, drive circuits, design of high frequency inductors and transformers, Voltage feed forward - PWM control and current mode control, Feedback compensators and design, unity power factor rectifiers.
Introduction to resonant converters - classification of resonant converters - Basic resonant circuit concepts. Zero current and Zero voltage switching, introduction to ZVT.

Text Book(s)

Ned Mohan et.al, 'Power Electronics', Third edition, John Wiley and Sons, 2003.
Robert Erickson, Maksimovic D, "Fundamentals of Power Electronics", Springer Science, 2007

Reference(s)
L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
George C. Chryssis, 'High Frequency Switching Power Supplies', McGraw-Hill International, 1999.
Abraham I. Pressman, 'Switching Power Supply Design', McGraw-Hill Company Inc, 1999.
Rashid, 'Power Electronics circuits, Devices, and Applications', Third Edition, Pearson Education, 2003

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE338	POWER PLANT INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems, Control Systems

Course Objective

To acquaint with theory and working principles of different types of instruments and control used in power plant automation.

Course Outcome

CO1: Familiarity with various components/equipment in power plants.
CO2: Understanding on process in different stages of power generation and transmission systems.
CO3: Familiarity with monitoring and control of boiler and turbine systems.
CO4: Exposure to automation of power plants.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	`-	-
CO4	3	-	1	-	2	-	-	-	-	-	-	-	2	-

Syllabus

Unit1
Introduction to Unit operation and Unit Process: Material and Energy Balance. Significance of Instrumentation and layout of thermal, hydroelectric, nuclear, gas turbine, solar, wind Power plants.
Concept of regional and national power grid. Concept of distance protections and islanding types of power plant.
Instrumentation and Equipments of Various Unit Operations: Evaporation, Distillation, leaching, Gas Absorption, Heat exchangers, Humidification and Dehumidification, Drying, Size Reduction, Crystallization, Mixing.

Unit2
Boiler Instrumentation and Optimization: Combustion control, 3 element drum level control, steam pressure, oxygen/CO/CO_2 – flue gases control, furnace draft, boiler interlocks, Start-up and shut-down procedures Boiler load calculation, boiler efficiency calculation.
SCADA controls- Boiler inspection and safety procedures.
Turbine Instrumentation and Control: Valve actuation, auto-start up, start up and shut down, thermal stress control, condition monitoring and Power Distribution Instrumentation. Auxiliary control of water treatment plant, Electrostatic Precipitator and Oil Automation System.

Unit 3
Automation: Thermal power plant, Boiler Automation – Diagnostic Functions and Protection – Digital Electro – Hydraulic Governor, Man-Machine Interface- Graphic Display of Automated Power plant.
Simulation experiments on SCADA, power plant monitoring and so on.

Text Book(s)

McCabe W.L, Smith J, Peter Harriot, "Unit operation of chemical Engineering", Seventh rev Edition, Tata McGraw Hill Publishing Company, , 2005.
Popovic and Bhatkar, "Distributed Computer control in Industrial automation", Second Edition, CRC Press, 1990.

Reference(s)
B.G.Liptak, "Instrument Engineers Handbook: Process Measurement and Analysis", Third Edition, Butterworth Heinemann, 1995.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE332	DEREGULATED POWER SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective

To expose to the deregulated power market operation, pricing mechanisms and electricity regulation and policies followed in India.

Course Outcome
CO1: Understanding of operation of deregulated power system and electricity market
CO2: Familiarity with Indian power sector acts, regulations and policies.
CO3: Ability to apply different pricing mechanism and market strategies.
CO4: Ability to evaluate techniques adopted in transmission congestion management, market settlement and tariff.

CO-PO Mapping

PO/PSO / *CO*	*PO1*	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*	*PSO1*	*PSO2*
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-		
CO3	3	3	-	-	-	-	-	-	-	-	-	-		
CO4	3	2	-	2	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Power Sector in India – Classical operation of power systems, least-cost operation, marginal cost, incremental cost - inter-utility interchanges. Fundamentals of deregulated power systems: Requirements and key issues - restructuring models - Independent system operators (ISOs).

Unit 2
Electricity market: Evolution and types of electricity markets - Competitive market - supply and demand functions, Market equilibrium - Market power and mitigation. Transmission Open Access: transmission pricing - pricing schemes - Concept of distribution factors – Location based marginal pricing.

Unit 3
Transmission capacity, Available Transfer capability (ATC) – Open Access Same Time Information Systems (OASIS) - Transmission congestion management - Ancillary Services: classifications and definitions – Indian Electricity Acts and Policies – 2003 Acts – Availability Based Tariff (ABT).

TEXT BOOKS / REFERENCES

Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", Springer, 2001.
M. Shahidehpour and M. Alomoush "Restructured Electrical Power Systems – Operation, Trading and Volatility", CRC Press, 2001.
Loe Lie Lai "Power Systems Restructuring and Deregulation", John Wily, 2001

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE341	RENEWABLE ENERGY AND ENERGY CONSERVATION	L-T-P-C: 3-0-0-3

Course Objectives

To introduce to electric power generation from renewable energy sources and familiarize to the concepts of electrical energy conservation.

Course Outcomes

CO1: Understanding of the energy scenario, renewable energy conversion and electrical energy conservation.
CO2: Knowledge on the characteristics of renewable energy sources and model the resource potential
CO3: Familiarity with renewable energy conversion and energy conservation technologies
CO4: Ability to compute and analyze performance of renewable energy conversion schemes and energy conservation methods.
CO5: Ability to design captive renewable energy conversion systems and industry specific energy conservation schemes.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO3	3	-	1		-	-	2	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	2	-	-	-	-	-	1	1
CO5	3	2	3	1	-	-	2	-	-	-	-	-	1	1

Syllabus

Unit 1

Historical development of energy demand and supply systems. Impact of fossil fuel based systems. Energy scenario — global and national; Renewable energy potential — global and national. Renewable energy technologies — stand-alone, hybrid and grid-connected systems.

Solar energy: Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, Sunpath diagrams, shadow determination. Extra terrestrial characteristics, effect of earth atmosphere, measurement & estimation on horizontal and tilted surfaces. Principle of photovoltaic conversion - dark and illumination characteristics, figure of merits of solar cell, efficiency limits, variation of efficiency with band-gap and temperature. Equivalent circuit. Crystalline and thin-film cells. Multi-junction cells. Concentrated PV cell.

Module, panel and array — series and parallel connections. Maximum power point tracking. SPV applications - battery charging, pumping and lighting, power plant. PV system design. Simulation case studies.

Small hydro power - resource assessment, environmental restrictions, SHP schemes — types, construction and equipment selection, load frequency control.

Unit 2

Wind energy: Atmospheric circulations. Wind shear and turbulence. Wind monitoring and resource assessment; Weibull parameters. Classification of wind regimes. Aerodynamic principles - lift and drag forces. Power coefficient and Betz limit. Types and characteristics of wind turbines.

Wind electric generation systems — grid-connected systems: WT-IG, WT-DWIG, WT-DOIG, WT-PMG and WT-VSIG. Comparison of performance. Small WEGs — stand-alone and hybrid system. Simulation case studies

Unit 3

Biomass energy — Gasifiers and dual fuel engines; Ocean-thermal energy conversion; Tidal energy conversion; Wave energy conversion; Geothermal energy conversion; MHD; Hydrogen and fuel cells.

Energy conservation in electrical equipment: Energy efficient lighting — luminous efficiency of lamps, efficient lamps, energy conservation codes and lighting design. Energy conservation in motors — estimation of operating efficiency of industrial motors, right selection of motor ratings, energy efficient motors; auto-stop control, delta-star operation, voltage control; Energy conservation in variable speed operation of pumps and fans — demerits of mechanical resistance control, advantages of variable speed drives, specific energy consumption, system design using VSD. Case studies.

TEXT BOOKS / REFERENCES

Thomas B Johansson et al, 'Renewable Energy sources for fuel and electricity-, Earthscan Publishers, London,1993

J W Twidell and A D Weir "Renewable Energy Resources", ELBS, 1998

G. N. Tiwari, M. K Ghosal, "Fundamentals of renewable energy sources", Alpha Science international Ltd, 2007

Garg H P, Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997

Kastha D, Banerji S and Bhadra S N, "Wind Electrical Systems", Oxford University Press, NewDelhi,1998

Tony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi, "Wind Energy Hand Book", John Wiley & Sons, 2004

S. C. Tripathy, "Electric energy utilization and conservation", Tata McGraw Hill Publishing company Ltd.,1987

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE344	ENERGY STORAGE SYSTEMS	L-T-P-C: 3-0-0-3

Course objectives

To understand the importance and application of energy storage systems and to familiarize with different energy storage technologies.

Course Outcome

CO1: Awareness of the role of energy storage in power systems.
CO2: Familiarity with different storage technologies and its applications.
CO3: Ability to apply energy storage technology in renewable energy integrations and smart grids
CO4: Ability to analyze the performance of Energy storage Systems
CO5: Exposure to economics of energy storage.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3	2	1											
CO4	3	2	1	1									1	1
CO5	3	1												

Syllabus

Unit 1
Introduction to energy storage for power systems: Applications of energy storage systems, Components of Energy Storage Systems, Types of storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems. Overview on Electrical energy storage: Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES).

Unit 2
Energy storage systems- configurations and applications. Charge and discharge mechanism of Batteries, Comparison of storage systems - Energy density, power density Storage for renewable energy Integration: Solar energy, Wind energy, Electric vehicle. Energy storage in Microgrid and Smart grid.

Unit 3
Management of storage systems, Battery Management Systems, Management of Hybrid Energy Storage Systems (HESS), Increase of energy conversion efficiencies by introducing energy storage, Storage technology for energy management, Economics of Energy storage.

TEXT BOOKS/ REFERENCES:

A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.

A. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN - 13:9789380090122), 2011.
Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.
Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) - A National Laboratory of the U.S. Department of Energy - Technical Report NREL/ TP6A2-47187, January 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

Cyber Physical Systems and Security

19CSE331	CRYPTOGRAPHY	L-T-P-C: 3-0-0-3

Course Objective

To learn core concepts of cryptography techniques and various algorithms.

Course Outcome

CO1: Understanding of classical cryptography techniques and apply crypto analysis
CO2: Ability to analyze measures for securing cryptosystem
CO3: Ability to apply and analyze operations on Feistel and non-Feistel structures
CO4: Ability to perform asymmetric encryption

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	1	3	-	-	-	-	-	-	-	3	-
CO2	3	3	2	-	3	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	3	-	-	-	-	-	-	-	3	2
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Basics of Number theory - Integers and Operations on Integers - Modular arithmetic - Prime Numbers – Primality related properties and Algorithms - Pseudo Random Number Generation. Classical Cryptography: Basic conventions and Terminology - Substitution Ciphers -Transposition ciphers - Rotor machines - Cryptanalysis.

Unit 2
Foundations of Modern Cryptography - Perfect Secrecy - Information and Entropy - Source Coding, Channel Coding, and Cryptography - Product cryptosystems. Symmetric Cryptosystems: Substitution permutation networks DES and Enhancements - AES and its Modes. Asymmetric Key Cryptography: Basic Ideas of Asymmetric Key Cryptography - RSA Cryptosystem.

Unit 3
Primality Testing - Square root modulo m-Factorization Algorithms - Attacks on RSA - Rabin Cryptosystem - Discrete Logarithm Problem and related Algorithms - ElGamal Cryptosystem - Introduction to Elliptic Curve Cryptography - Hash Functions and Message Authentication: Data Integrity - Security of Hash functions - Iterated Hash Functions - Message Authentication.

Textbooks/References:
Padmanabhan T R, Shyamala C K and Harini N, “Cryptography and Security”, First Edition, Wiley Publications, 2011.
Stallings W, “Cryptography and Network Security”, Third Edition, Pearson Education Asia, Prentice Hall, 2000.
Forouzan B A, “Cryptography and Network Security”, Special Indian Edition, Tata McGraw Hill, 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE332	INFORMATION SECURITY	L-T-P-C: 3-0-0-3

Course Objective

To understand information security models, email security and web security and their applications in E-Commerce.

Course Outcome

CO1: Understanding of information security models and analyze authentication mechanisms for challenge response scenarios.
CO2: Familiarize with e-mail architecture and standards for securing mail communication
CO3: To introduce to Internet security protocol and explore common solutions for security issues.
CO4: Ability to analyze web security protocols for E-Commerce applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	1	3	2	3	-	-	-	-	-	-	-	2	3
CO4	3	3	3	2	3	-	-	-	-	-	-	-	2	3

Syllabus

Unit 1

Digital Signature and Authentication Schemes: Digital signature-Digital Signature Schemes and their Variants- Digital Signature Standards-Authentication: Overview- Requirements Protocols -Applications - Kerberos -X.509 Directory Services.

Unit 2

Electronic mail security: Email Architecture -PGP – Operational Descriptions- Key management- Trust Model-S/MIME.IP Security: Overview- Architecture - ESP, AH Protocols IPSec Modes – Security association - Key management.

Unit 3

Web Security: Requirements- Secure Sockets Layer- Objectives-Layers -SSL secure communication-Protocols - Transport Level Security. Secure Electronic Transaction- Entities DS Verification-SET processing.

Text Book(s)

Stallings W, "Cryptography and Network Security", Third Edition, Pearson Education Asia. Prentice Hall, 2000.

Reference(s)

Padmanabhan T R, Shyamala C K and Harini N, "Cryptography and Security", First Edition, Wiley India Publications, 2011.
Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007.

Evaluation pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE366	CYBER SECURITY	L-T-P-C: 3-0-0-3

Pre-requisites: IT Essentials, Computer Programming I

Course Objective

To understand the relevance and potential of computer security for ever increasing number of applications.

Course Outcome

CO1: Ability to understand fundamentals concepts of computer security and apply to different components of computing systems.
CO2: Ability to identify the basic cryptographic techniques using existing softwares in information security.
CO3: Ability to describe malicious attacks, threats, and protocols for security vulnerabilities and its impact on a systems infrastructure.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-
CO2	3	3	2	-	3	-	-	-	-	-	-	-	3	-
CO3	3	3	2	2	3	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1

Basics of Computer Security : Overview - Definition of terms - Security goals - Shortcomings - Attack and defense - Encryption and Cryptography : Ciphers and codes - Public key algorithms - Key distribution - Digital signatures - Pretty good privacy

Unit 2

Authentication and Key Exchange Protocols : Directory authentication service - Diffie-Hellman key exchange – Kerberos -Software Security : Malicious code - Worms - Intruders - Error detection and correction - OS protection policies - Trusted Systems : Memory protection - Access control matrix - User authentication

Unit 3

Security models - Disaster recovery -Database Security: Integrity constraints - Multi-phase commit protocols - Networks Security : Threats in networks - DS authentication -Web and Electronic Commerce : Threats on the web - Secure socket layer - Client-side certificates - Applet security model

TEXTBOOKS/REFERENCES

Stallings William, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson/Prentice- Hall, 2013.
Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007.
Padmanabhan TR, Shyamala C K, and Harini N, "Cryptography and Security", First Edition, Wiley India Publications, 2011.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE469	INFORMATION RETRIEVAL	L-T-P-C: 3-0-0-3

Pre-requisites: Data Base Systems and Programming

Course Objective

To understand the concepts and mathematics behind the information retrieval algorithms and different data classification algorithms.

Course Outcome

CO1: Understanding of information retrieval concepts
CO2: Familiarity with classical retrieval models
CO3: To introduce to performance evaluation methods
CO4: Ability to comprehend various classification algorithms

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	3	-	-	-	-	-	-	2	-
CO2	3	-	-	2	-	3	-	-	-	-	-	-	2	-
CO3	3	-	3	2	-	3	-	-	-	-	-	-	2	-
CO4	3	-	3	3	3	3	-	-	-	-	-	-	3	2

Syllabus

Unit 1

Introduction to Information Retrieval, Text Indexing, Storage and Compression-Text encoding: tokenization, stemming, stop words, phrases, index optimization. Dictionary structures, wild card quereies, spelling corrections, Index construction. Index compression: lexicon compression and postings list compression. Gap encoding, gamma codes, Zipf's Law. dynamic indexing, positional indexes, n-gram indexes, Postings size estimation, real-world issues.

Unit 2

Retrieval Models-Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio. Performance Evaluation-Evaluating search engines. User happiness, precision, recall, F-measure. Creating test collections: kappa measure, interjudge agreement.

Unit 3

Text Categorization and Filtering-Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting. Text Clustering-Clustering versus classification. Partitioning methods. k-means clustering. Mixture of gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents.

Text book/ Reference(s)

Introduction to Information Retrieval Manning, Raghavan and Schutze, Cambridge University Press, draft.
Modern Information Retrieval Baeza-Yates and Ribeiro-Neto, Addison Wesley, 1999.
Mining the Web, Soumen Charabarti, Morgan-Kaufmann, 2002.
NPTEL - http://cse.iitkgp.ac.in/~pabitra/course/ir06/ir06.html.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE470	DIGITAL FORENSICS	L-T-P-C: 3-0-0-3

Course Objective

To understand core concepts of computer aided forensics technologies and to investigate cyber threats and attacks.

Course Outcome

CO1: Ability to plan and prepare for various stages of an investigation - detection, initial response and management interaction.
CO2: Ability to investigate attacks and learn the importance of evidence handling and storage.
CO3: Ability to summarize preservation of digital evidence

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	3	-	-	-	-	-	-	-	3	3
CO3	3	3	2	2	3	-	-	-	-	-	-	-	2	3

Syllabus

Unit 1
Forensics Overview: Computer Forensics Fundamentals, Benefits of Computer Forensics, Computer Crimes, Computer Forensics Evidence and the Courts, Legal Concerns and Privacy Issues. Forensics Process: Forensics Investigation Process,

Unit 2
Securing the Evidence and Crime Scene, Chain of Custody, Law Enforcement Methodologies, Forensics Evidence, Evidence Sources. Evidence Duplication, Preservation, Handling, and Security, Forensics Soundness, Order of Volatility of Evidence, Collection of Evidence on a Live System, Court Admissibility of Volatile Evidence.

Unit 3
Acquisition and Duplication: Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, File System Analysis, Performing Searches, Recovering Deleted, Encrypted, and Hidden files, Internet Forensics, Reconstructing Past Internet Activities and Events, E-mail Analysis, Messenger Analysis: AOL, Yahoo, MSN, and Chat. Mobile Device Forensics: Evidence in Cell Phone, PDA, Blackberry, iPhone, iPod, and MP3. Evidence in CD, DVD, Tape Drive, USB, Flash Memory, Digital Camera, Court Testimony, Testifying in Court, Expert Witness Testimony, Evidence Admissibility

Textbooks/References:
Jason Luttgens, Matthew Pepe, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill Osborne Media, 3 rd edition , 2014.
Keith J. Jones, Richard Bejtlich, Curtis W. Rose, Real Digital Forensics: Computer Security and Incident Response, Paperback – Import, 2005.
John Sammons, The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics Paperback, February 24, 2012.
Hacking Exposed: Network Security Secrets & Solutions, Stuart McClure, Joel Scambray and George Kurtz, McGraw-Hill, 2005.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Electro-Biological Systems

19EEE430	BIOMEDICAL SYSTEMS	L-T-P-C: 3-0-0-3

Course objective

To introduce aspects of biomedical engineering from a systems perspective and to use the engineering principles for extracting bio medical information.

Course Outcomes

CO1: Ability to acquire, process and analyze the biomedical signals
CO2: Knowledge on measurement and interpretation of data from biological sensors
CO3: Ability to apply medical informatics and artificial intelligence methods for biomedical decision making.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3	2		1	1			1					1	

Syllabus

Unit 1:
Biomedical signals: origins and dynamic characteristics, Biomedical signal acquisition and processing. Compression of biomedical signals, Analysis of biomedical signal using advanced techniques (e.g. neural networks, orthogonal transformations including singular value decomposition) and wavelet transformation, higher order spectra).
Unit 2:
Nonlinear dynamical analysis of biomedical signals, Physiological modelling, identification and simulation. Control of physiological processes and computer controlled drug infusion medical signaling (including CT Scan, MRI and Ultrasound). Medical Informatics, Artificial intelligence methods for medical decision making
Unit 3:
Study of biological sensors: Sensors / receptors in the human body, basic organization of nervous system-neural mechanism and circuit processing. Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, osmolality and taste. Sensor models in the time and frequency domains.

Textbooks/References

R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill, 2014
Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia,2002
Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India,2001

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE439	BIOINFORMATICS	L-T-P-C: 3-

Course Objectives

To learn concepts of DNA, protein structures and learn to work with computer aided drug designs, docking, screening etc.

Course Outcome

CO1: Understanding DNA sequence analysis using biological sequence data from online repositories
CO2: Familiarize with protein structural analysis and perform protein structure prediction
CO3: Introduce to computer aided drug design, docking, screening, QSAR.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	3
CO2	3	1	-	-	3	-	-	-	-	-	-	-	3	-
CO3	3	1	2	1	3	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Introduction to genes and proteins, organization of DNA, RNA and protein, Motifs, Restriction maps and Restriction enzymes, DNA sequence analysis, DNA Databases, Searching scientific information using search engines, Protein structure and function, protein sequence databases, sequence alignment, PAM matrix, Global and local alignment, BLAST: features and scores, Multiple sequence alignment, Conservation score, phylogenetic trees,
Unit 2
Protein sequence analysis, hydrophobicity profiles, non-redundant datasets, Protein secondary structures, Ramachandran plot, propensity, secondary structure prediction, Protein tertiary structure, Protein Data Bank, visualization tools, structural classification, contact maps, Protein structural analysis, protein structure prediction.
Unit 3
Protein stability, energetic contributions, database, stabilizing residues, stability upon mutations, Protein folding rates, proteins interactions, binding site residues, Computer aided drug design, docking, screening, QSAR.

Text book/References
1. M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Academic Press, 2010.
2 D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE451	BIOLOGICAL CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives

To impart knowledge on modeling and control of biological systems.

Course Outcomes

CO1: Understanding of dynamics of cardiac, respiratory, neuromuscular systems.
CO2: Ability to model and characterize the cardiac, respiratory, Neuro muscular systems in time and frequency domains.
CO3: Ability to analyze the stability of biological systems.
CO4: Ability to apply the adaptive control scheme for biological systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3				-		-	-	-	-	-	-		-
CO2	3	2		1	-		-	-	-	-	-	-	-	-
CO3	3	2	2	1	-		-	-	-	-	-	-	-	-
C04	3	2	2	2	2								1	1

Syllabus

Unit1:
Biological Control Systems Analysis. Comparison of Engineering and Biological Control System. Mathematical modelling of Biological (Physiological) Systems: Transfer function and State-Space Analysis, Computer Analysis and Simulation.

Unit2:
Static Analysis of Biological Systems: Regulation of Cardiac Output, Regulation of Glucose, Chemical Regulation of Ventilation. Time-Domain Analysis: Linearized Respiratory Mechanics, Dynamics of Neuromuscular Reflex Motion. Frequency-Domain Analysis of Biological systems: Frequency Response of a Model of Circulatory Control, Frequency Response of Glucose-Insulin Regulation.

Unit3:
Stability Analysis: Stability Analysis of the Pupillary Light Reflex Model of Cheyne-Stokes Breathing. Identification of Biological Control Systems: Identification of Closed-Loop Systems, Case studies. Optimization in Biological Control: Adaptive Control of Biological Variables. Nonlinear Analysis of Biological Control Systems: Models of Neuronal Dynamics

Text Books/ References

Michael C.K. Khoo, "Physiological Control Systems: Analysis, Simulation and Estimation". John Wiley & Sons, Inc., 2012.
Schlick, T., " Molecular Modeling and Simulation: An Interdisciplinary Guide". New York, NY: Springer, 2002.
Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
Barry R. Dworkin, "Learning and Physiological Regulation (Hardcover)", University Of Chicago Press, March 1993.
E. Carson, E. Salzsieder, "Modelling and Control in Biomedical Systems ", 2000 (including Biological Systems) (IFAC Proceedings Volumes) (Paperback), Pergamon Publishing.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ECE331	BIOMEDICAL INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requisites: Sensors and Sensor Circuit Design

Course Objective

To introduce to the concept of bio signals, its acquisition, conditioning and imaging techniques used in bio medical instrumentation.

Course Outcome

CO1: Understanding on basics of bio-medical signals and sensors
CO2: Ability to apply the concepts of sensors and transducers for acquiring bio-signals and related signal conditioning circuits.
CO3: Familiarity with therapeutic and diagnostic methods using bio-medical instrumentation systems
CO4: Learning on modern methods of imaging techniques used for bio-medical applications and related standards

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-												
CO2	3	2	1											
CO3	3													
CO4	3				2			2					1	1

Syllabus

Unit 1
Cell resting potential and action potentials - Origin of bio potentials - characteristics – Frequency and amplitude ranges - ECG – Einthoven's triangle – 3 lead ECG system - EEG – 10- 20 electrode system - Origin and characteristics of EMG – EOG - ERG electrodes and transducers. Electrode-electrolyte interface – Electrode – skin interface - Half cell potential – Impedance - Polarization effects of electrode – Nonpolarizable electrodes. Types of electrodes - Surface; needle and micro electrodes – ECG – EMG - EEG Electrodes.

Unit 2
Diagnostic and Therapeutic Equipments: Blood pressure monitors – Electrocardioscope - Pulse Oximeter - pH meter - Auto analyzer – Pacemakers – Defibrillator - Heart lung machine - Nerve and muscle stimulators - Dialysis machines - Surgical diathermy equipments – Nebulizer; inhalator - Aspirator – Humidifier - Ventilator and spirometry.

Unit 3
Medical imaging techniques: Basics of diagnostic radiology – Production - Nature and properties of X rays - X-ray machine - Block diagram - Digital radiography – CT - Basic Principle - Block diagram – Radioisotopes in medical diagnosis – Physics of radioactivity – Gamma Camera. Block diagram – SPECT Scanner – PET Scanner - Principles of NMR Imaging systems - Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Physics of Ultrasound waves – Doppler effect – Medical Ultrasound - Robotic Surgery – Advanced 3D sugical techniques - Electrical Safety codes and standards – Protection of patients. Case study – wireless health monitoring.

TEXT BOOK / REFERENCES

R S Khandpur, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2014.
John G Webster, "Medical Instrumentation - Application and Design", 4th ed., John Wiley and Sons, 2007.
Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, "Biomedical Instrumentation & Measurements, 2nd ed., Pearson Education., 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Automotive Systems

19EEE432	VEHICULAR NETWORKS AND COMMUNICATION	L-T-P-C: 3-0-0-3

Course Objectives

To expose to the communication requirements and capabilities of automobiles and various protocols, standards and applications for in-vehicle, V2I and V2V communications.

Course Outcome

CO1: Knowledge on communication technologies, protocols and standards of automotive systems
CO2: Familiarization with vehicular network models and functions
CO3: Ability to analyze the protocols and standards for V2V and V2I communication

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	2	-	1	-	-	-	-	-	-	-	3	1

Syllabus

Unit 1
Introduction to vehicular communications- Overview on transportation networks, Evolution of transportation models, Vehicular network standardization, Vehicular communication technologies,Vehicular network (VN) model- Cluster-based vehicular networks, Vehicle platooning, Vehicular cloud, Hybrid sensor–vehicular networks, Information distribution, Internet of Vehicles,

Unit 2
Vehicular Networks: Cross-System Functions, Requirements for Bus Systems, Classification of Bus Systems, Application in The Vehicle, Coupling of Networks, Examples of Networked Vehicles; Bus Systems: CAN Bus, CAN-FD, LIN Bus, MOST Bus Bluetooth, Flex Ray,

Unit 3
Vehicular Communications: Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC: Inter- Vehicle Communications- Mobile Wirless Communications and Networks- Architecture Layers-Communication Regime.V2V, V2I-VANET-WAVE; DSRC.

TEXT BOOKS/REFERENCES:

Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire", Wiley,2007.
Dominique Paret, "FlexRay and its Applications: Real Time Multiplexed Networks", Second Edition, Wiley,2012.
Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication", Springer,2010.
Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015.
Laun T.H, Shen X. (Sherman) and Bai F, "Enabling Content Distribution in Vehicular AdHoc Networks", Springer, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE433	E-MOBILITY BUSINESS AND POLICIES	L-T-P-C: 3-0-0-3

Course Objectives

To impart knowledge on the need of policies for Electric Vehicle charging and infrastructure requirements.

Course Outcome

CO1: Understanding the models used in public transportation system
CO2: Familiarize the concept of shared mobility services, advantages and monitory benefits
CO3: Introduce to the infrastructure requirements for electric vehicle charging
CO4: Ability to comprehend, design and develop policies for electric vehicle charging

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO4	3	-	3	-	2	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Introduction to India's passenger mobility sector- Current State of India's Public Transport System, Public Transport: Efficiently and Affordably Mobilizing Cities, Opportunities To Maintain And Ideally Increase The Utilization Of Public Transport In India, Expanding India's Definition Of Public Transport Through Data And New Business Models.

Unit 2
India's Path Forward In Public Transport, Sharing and Mobility Services: Unlocking Economic Electrification- the business case for shared, electric mobility services, Examples of Shared Mobility Services Active In Today's Global Marketplace- Ride-Hailing Services: Pooled Ride-Hailing Services: Vehicle Sharing: Peer-To-Peer Vehicle Sharing: Fixed-Route Commuter Services: Incentives to promote electric mobility and sharing: Parking and pick-up benefits: Road toll and road tax discount or exemption: Licensing and registration benefits.

Unit 3
Congestion pricing: Low-emission zones: EV Charging Infrastructure: Powering EVs and Recharging 4 India's Electricity Sector: Considerations and Implications For India's EV Charging Infrastructure Deployment Standards: EV standards-IEEE, IEC and SAE, Basics of EV charging, EV charging standards and infrastructure, Smart Parks, V2G, G2V, V2B, V2H, renewable energy integration to EV charging infrastructure.

TEXT BOOK/REFERENCES:

Emadi, A. (Ed.), Miller, J., Ehsani, M. (2003). Vehicular Electric Power Systems. Boca Raton: CRC Press.
Husain, I. (2010). Electric and Hybrid Vehicles. Boca Raton: CRC Press.
Larminie, James, and John Lowry. Electric Vehicle Technology Explained. John Wiley and Sons, 2012.
Tariq Muneer and Irene Illescas García, 1 - The automobile, In Electric Vehicles: Prospects and Challenges, Elsevier, 2017, Pages 1-91.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE434	AUTOMOTIVE ELECTRONICS	L-T-P-C: 3-0-0-3

Pre-requisites: Circuits Analysis, Control Systems

Course Objectives

To introduce the electrical, electronics and communication networks and components used in Electric Vehicles

Course Outcome

CO1: Understanding of the basic principles of electronic systems, power train control systems, electrical and communication systems in electric vehicles.
CO2: Ability to analyze the performance of various control systems, engine management and electrical networks and components in electric vehicles
CO3: Ability to design electronic systems, power train, engine management, battery and communication systems for electric vehicles.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction to Electronic systems in Automotives – Sensors and Actuators for body electronics, power train and chassis systems. Body electronics domain- Automotive alarms, Lighting, Central locking and electric windows, Climatic Control, Driver information, Parking, etc.

Unit 2
Power train and chassis control domain – Engine management, Transmission control, ABS, ESP, Traction Control, Active Suspension, passive safety, Adaptive Cruise Control, etc. Hardware implementation example of simple automotive systems using Sensors, Controller, Actuators etc.

Unit 3
Battery- types and maintenance, Alternators in vehicles, Starting motor systems, Electrical circuits and wiring in vehicles, vehicle network and communication buses – Digital engine control systems, Introduction to automotive controllers, On-Board Diagnostics (OBD).

TEXT BOOKS/REFERENCES:
Bosch,"Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive", Fifth edition, Springer view 2014.
Najamuz Zaman, "Automotive Electronics Design Fundamental'' First edition, Springer 2015.
Hillier's, "Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics", Fifth Edition, Nelson Thrones, 2007.
William B. Ribbens, "Understanding Automotive Electronics" Sixth Edition, Elsevier Newnes, 2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE435	AUTOMOTIVE CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives: To impart knowledge on modeling and analysis of vehicle dynamics and design controllers for automotive systems.

Course Outcomes
CO1: Understanding of vehicle dynamics and road-driver models. (BTL-2)
CO2: Ability to diagnosis the vehicle faults using fault models.(BTL-3)
CO3: Ability to analyze the ABS control systems.(BTL-4)
CO4: Ability to develop a complete driver model with path, road surface and wind strength.(BTL-5)

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	2	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	2	-	-	-	-	-	-	-	-	-
CO4	3	1	3	2	2	-	-	-	-	-	-	-	1	1

Syllabus
Unit 1
Overview of Control System: Modeling, Time/Frequency Response Analysis And Stability Analysis: PID, State Variable Analysis.
Model Based Diagnosis: Characteristics, Faults, Fault Modeling, Principles Of Model Based Diagnostics- Residual Generator Design, Residual Evaluation, Engineering Of Diagnosis Systems, Application Example.
Unit 2
Vehicle Control Systems: ABS Control Systems- Torque Balance At Vehicle- Road Contact, Control Cycles Of The ABS System, ABS Cycle Detection; Control Of Yaw Dynamics- Deviation Of Simplified Control Law, Derivation Of Reference Values.
Unit 3
Road and Driver Models: Road Model- Requirements of The Road Model, Definition of The Course Path, Road Surface and Wind Strength; PID Driver Model; Hybrid Driver Model – Vehicle Control Tasks, Characteristics of Human as A Controller, Information Handling, Complete Driver Model.
Simulation/case studies on relevant topics.

TEXT BOOKS/REFERENCES

Kiencke, Uwe and Nielsen, Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", Springer, 2005
I.J Nagrath and M.Gopal, "Control Systems Engineering", Wiley Eastern Limited, New Delhi, 2008.
M.Gopal, "Modern Control System Theory", New Age International,2005.
Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE436	VEHICLE DYNAMICS AND CONTROL	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives

To understand the concept of vehicle dynamics and analyze the parameters for adaptive vehicular control

Course Outcome

CO1: Understanding of concepts in vehicle dynamics and control.
CO2: Knowledge on control system architecture and adaptive vehicular control.
CO3: Ability to design and develop controllers for braking system in Electric vehicle.
CO4: Ability to analyze the electronic stability control in Electric Vehicles.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	2	-	-	-	-	-	-	-	1	1
CO4	3	2	3	1	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction To Driver Assistance Systems, Active Stability Control, Ride Quality, Technologies For Addressing Traffic Congestion, Emissions And Fuel Economy; Lateral Vehicle Dynamics: Kinematic Models, Dynamic Bicycle Model, From Body Fixed To Global Coordinates: Lateral Vehicle Control: State Feedback, Steady State Analysis: Understanding Steady State Comering, The Output Feedback Problem, Compensator Design With Look Ahead Measurement; Longitudinal Vehicle Dynamics: Longitudinal Vehicle Model, Driveline Dynamics, Mean Value Engine Models.

Unit 2
Longitudinal Vehicle Control: Introduction: Cruise Control, Control System Architecture, Adaptive Cruise Control, Individual Vehicle Stability and String Stability, String Stability with Constant Spacing, String Stability with Constant Time Gap, Controller for Transitional Maneuvers, Automated Highway Systems, Longitudinal Control for Vehicle Platoons, String Stability with Inter- Vehicle Communication, Adaptive Controller for Unknown Vehicle Parameters.

Unit 3
Electronics Stability Control: Vehicle Model, Control Design for Differential Braking Based Systems, Control Design for Steer-By-Wire System, Independent All Wheel Drive Torque Control: Active Automotive Suspensions: H2 Optimal Control, LQR Formulation for Active Suspension Design, Analysis of Trade-Offs Using Invariant Points, Performance of The Sky-Hook Damping Controller, Control with Hydraulic Actuators;
Lab Experiments Based on Simulation Tools.

TEXT BOOKS/REFERENCES:

Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International, 1992.
R. Rajamani, "Vehicle Dynamics and Control", Second Edition, Springer Verlag 2012.
Uwe Kiencke and Lars Nielsen, "Automotive Control Systems: For Engine Driveline, and Vehicle", Second edition, Springer, 2005.
John C Dixon, "Tyres, Suspension and handling", 2nd Revised Edition, SAE International, 1996.
Hans B. Pacejka, "Tyre and Vehicle Dynamics", Second Edition, Butterworth-Heinemann, 2006.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE437	ELECTRIC VEHICLE TECHNOLOGY	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical machines, Power electronics & Drives

Course Objectives

To impart knowledge on electric drives, energy storage and energy management in electric vehicles with special reference to big data analytics and communication networks.

Course Outcome

CO1: Understanding of electric vehicles architecture, vehicle propulsion system and vehicular communication protocols.
CO2: Ability to apply concepts of electric drives, energy storage and communication in xEV.
CO3: Exposure to big data analytics in vehicular network control

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2		-	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1

xEV:- Introduction to xEV's :BEV, HEV, PEV, FCEV- Configuration of Electric Vehicles, Performance of Electric Vehicles, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains. Basics different EV motor drives, Configuration and control of Drives-Energy Storage and power electronics for battery charging and grid interface: Energy Storage Requirements in (Hybrid and) Electric Vehicles:- Battery based energy storage, Fuel Cell based energy storage , Hybridization of different energy storage devices. EV and PHEV Battery Charging: Grid and Renewable Energy Interface topologies, Regenerative braking. Energy Management Strategies: classification, comparison and implementation issues of EMS, On-board power electronic battery Management.

Unit 2

Vehicular Networks: Cross-System Functions, Requirements For Bus Systems, Classification Of Bus Systems, Application In The Vehicle, Coupling Of Networks, Examples Of Networked Vehicles; Bus Systems: CAN Bus , CAN-FD, LIN Bus, MOST Bus Bluetooth, Flex Ray, Diagnostic Interfaces: Implementation Of Body Electronics Functionalities Using Controllers. Control Systems for the HEV and EVs:, On-Board Diagnostics (OBD), Introduction to autonomous driving.

Unit 3

Vehicular network (VN) model- Cluster-based vehicular networks, Vehicle platooning, Vehicular cloud, Hybrid sensor–vehicular networks, Information distribution, Internet of Vehicles, Vehicular cloud networking: architecture and design principles, Hybrid sensor and vehicular networks, Vehicular network as business model in Big Data- Big Data technology in vehicular networks, Data validation in Big Data, Real-time analysis of Data in VANET, Vehicular density analysis using Big Data, Vehicular carriers for Big Data, Big Data technologies in support of real-time capturing and understanding of electric vehicles, Future trends and challenges in ITS, Introduction to security and privacy issues in vehicular networks.

Textbook/References

M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2015
Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", Second Edition, CRC Press, 2011.
Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.
James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. Intelligent Vehicular Networks and Communications. Elsevier Science and Technology Books, Inc. 2017
Wai Chen, "Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment" , Elsevier Science and Technology Books 2015
Laun T.H, Shen X.(Sherman) and Bai F, "Enabling Content Distribution in Vehicular AdHoc Networks", Springer, 2014.
Bob McQueen, "Big Data Analytics for Connected Vehicles and Smart Cities", Artech

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Embedded Systems, Robotics & Artificial Intelligence

19CSE350	INTERNET OF THINGS	L-T-P-C: 3-0-0-3

Course Objective

To understand the basics of IoT devices and its interfacing.

Course Outcomes

CO1: Knowledge on internet of things and its hardware & software components
CO2: Ability to interface I/O devices, sensors and communication modules
CO3: Ability to remotely monitor data and control devices
CO4: Ability to develop real life IoT based projects

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	1												
CO3	3	2			1									
CO4	3	2	2	1	2								1	1

Syllabus

Unit 1
Introduction to IOT: Architectural Overview, Design principles & needed capabilities, IOT applications, sensing, actuation, basics of networking, M2M and IOT technology fundamentals-devices and gateways, data management, business processes in IOT, everything as a service(XaaS), role of cloud in IOT, Security aspects in IOT.

Unit 2
Elements of IOT: Hardware Components- computing(Arduino, Rasperry pi), communication, sensing, actuation, I/O interfaces. Software components- Programming API's (using python/Node.js/arduino) for communication protocols-MQTT,ZigBee, Bluetooth, CoAP, UDP, TCP.

Unit 3
Solution framework for IOT applications- implementation of device integration, data acquisition and integration, device data storage- unstructured data storage on cloud/local server, authentication, authorization of devices, Case studies.

Text Books/ References:
Vijay madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on approach". University Press.
Dr.SRN Reddy, Rachit Thukral and manasi Mishra, "Introduction to Internet of Things: A Practical Approach", ETI Labs.
Pethuru raj and Anupama C Raman, "The Internet of things: Enabling Technologies, Platforms, and use cases" CRC Press.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE363	ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Pre-requisites: Probability and statistics, matrix algebra

Course Objective

To learn concepts of Artificial Intelligence and develop programs for self learning agents.

Course Outcome

CO1: Ability to apply intelligent agents and search algorithms to games
CO2: Ability to solve AI problems through programming in python.
CO3: Learning optimization and inference algorithms for model learning
CO4: Ability to develop programs to learn and act in a structured environment

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	3	-	-	-	-	-	-	-	3	-
CO3	3	2	2	-	3	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Introduction: Overview and Historical Perspective, Turing test, Physical Symbol Systems and the scope of Symbolic AI, Agents. State Space Search: Depth First Search, Breadth First Search, DFID. Heuristic Search: Best First Search, Hill Climbing, Beam Search, Tabu Search.

Unit 2
Randomized Search: Simulated Annealing, Genetic Algorithms, Ant Colony Optimization. Finding Optimal Paths: Branch and Bound, A*, IDA*, Divide and Conquer approaches, Beam Stack Search. Problem Decomposition: Goal Trees, AO*, Rule Based Systems, Rete Net. Game Playing: Minimax Algorithm, AlphaBeta Algorithm, SSS*.

Unit 3
Planning and Constraint Satisfaction: Domains, Forward and Backward Search, Goal Stack Planning, Plan Space Planning, Graphplan, Constraint Propagation. Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and Backward chaining.

Textbooks
John Haugeland, Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985.

Reference(s)

Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.
Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011.
Pamela McCorduck, Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, A K Peters/CRC Press; 2 edition, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE367	DIGITAL IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objective: To learn mathematical formulations and processing techniques in 2D spatial and frequency domain for processing digital images.

Course Outcome

CO1: Knowledge on various concepts of 2D images and mathematical transforms necessary for image processing
CO2: Ability to apply image processing techniques in spatial and frequency domain
CO3: Ability to analyze filtering in spatial and frequency domain
CO4: Ability to develop software to understand image processing techniques with simple examples

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	1	-	-	-	-	-	-	-		
CO4	3	3	3	3	3	-	-	1	1	-	-	-	2	1

Syllabus

Unit 1
Digital image fundamentals-Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model, Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models.

Unit 2
2D Transforms- DFT, its properties, Walsh transform, 15 Hadamard transform, Haar transform. Image enhancement- Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter, **Image restoration**-Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration.

Unit 3
Image segmentation-Classification of Image segmentation techniques, region approach, clustering techniques,Classification of edges, edge detection, Hough transform, active contour **Image compression** Image compression standards- JPEG& MPEG, vector quantization, wavelet based image compression.

Text Book(s)
Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009.
S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing ,Tata Mc Graw Hill, 2015.

Reference(s)
Jain Anil K , Fundamentals of digital image processing: , PHI,1988.
Kenneth R Castleman , Digital image processing:, Pearson Education,2/e,2003 3. Pratt William K , Digital Image Processing: , John Wiley,4/e,2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE352	DIGITAL CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course objective

To characterize the discrete-time system in both time and frequency domains and design digital controllers.

Course Outcomes

CO1: Understanding of sampling process and Z-transform.
CO2: Ability to solve the pulse transfer function of discrete time systems.
CO3: Ability to analyze the behavior and stability of discrete time systems in Z-plane.
CO4: Ability to apply lag-lead compensation in closed loop systems for the desired time/frequency response.
CO5: Ability to design of digital state-feedback controller and state-observers.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	2	-	-	-	-	-	-	-	1	1
CO5	3	3	3	-	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Review of Z-transforms. Pulse transfer function. Digital control system: sampling, quantization, data reconstruction and filtering of sampled signals. Mathematical modeling of sampling process. Simulation examples- effect of sampling rate.

Unit 2
Stability analysis of closed loop systems in the z- plane: root loci, frequency domain analysis, Stability tests. Discrete equivalents. Digital controller design for SISO systems: design based on root locus method in the z-plane, design based on frequency response method, design of compensators, design of PID Controller.

Unit 3
2DOF discrete PID controller- software approach. State space representation in discrete system. Controllability, observability, control law design, decoupling by state variable feedback, effect of sampling period. Estimator/ Observer Design: full order observers, regulator design. Discrete LQR design. Simulation experiments in controller, observer/estimator, discrete LQR design and so on.

Text Books:
K. Ogata, "Discrete-Time Control Systems", Pearson Education, 2011.
Gene F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Pearson, 3rd Edition, 2006.

References:

M. Sami Fadali, Antonio Visioli, "Digital Control Engineering: Analysis and Design", Elsevier, 2013.

IoanDoré Landau, GianlucaZito, "Digital Control Systems: Design, Identification and Implementation", Springer, 2006.

Cheng Siong Chin, "Computer-Aided Control Systems Design" CRC Press, 2013.

Hemchandra Madhusudan Shertukde, "Digital Control Applications-Illustrated with MATLAB" CRC Press Inc., 2015.

C. L. Philips, Troy Nagle, AranyaChakrabortty, "Digital Control System Analysis and Design", Prentice-Hall, 2014.

M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE353	PROCESS CONTROL AND INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course Objective

This course covers basics of process control and instrumentation, followed by modelling of various systems and design of controllers for different applications.

Course Outcomes

CO1: Ability to develop transfer function and state-space models for linear dynamic processes
CO2: Understanding on feedback and feedforward controllers
CO3: Ability to design PID controllers using different tuning rules
CO4: Ability to evaluate the performance of control loop systems.
CO5: Familiarization of automation in process control

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	1	-	-	-	-	-	-	-	-	
CO4	3	3	3	2	1	-	-	-	-	-	-	-	-	
CO5	3	1	-	-	2	-	-	-	-	-	-	-	1	

Syllabus

Unit 1
Process Modelling: hierarchies. Theoretical models: transfer function, state space models, and time series models. Development of empirical models from process data, chemical reactor modelling. Identify the various instrumentations required for process control.

Unit 2
Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio, split range, selective, override, auctioneering, adaptive and inferential controls. Multi-loop and multivariable control: process interactions, Singular value decomposition, Relative gain array, I/O pairing. Decoupling and design of non-interactive control loops. PID design, tuning, trouble shooting, tuning of multiloop PID control systems. Decoupling control: strategies for reducing control loop interactions.

Unit 3
Instrumentation for process monitoring: codes and standards, preparation of process flow, P&I diagrams. Statistical process control, supervisory control, direct digital control, distributed control, PC based automation. Programmable logic controllers: organization, programming aspects, ladder programming, final control elements. SCADA in process automation. Case studies.
Lab Practice: Simulation/hardware experiments in PID controller, PLC and so on.

Text Books/ References:

Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle "Process Dynamics and Control", John Wiley & Sons, 2015.

Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 2012.

Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 5th edition, 2014.

Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.

W. Bolton, "Mechatronics", Pearson, 6th Edition, 2015

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE354	INTRODUCTION TO ROBOTICS	L-T-P-C: 3-0-0-3

Pre-requisites: Matrix Algebra

Course Objective
This course introduces the fundamentals, kinematic and inverse kinematic control of manipulators and mobile robots.

Course Outcome

CO1: Understanding of mathematical modeling of rigid bodies
CO2: Learning on kinematic and inverse kinematic models of manipulators
CO3: Exposure to systems and navigation of wheeled mobile robots.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	1	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Mathematical representations of rigid bodies in 3D space, the concept of a 4 x 4 homogeneous transformations and elementary screw theory. Lab: Simulations of different kinds of actuators and their mathematical models.

Unit 2
Fundamentals of kinematics, Symbolic representation of robots: representation of joints, link representation using D-H parameters, kinematics of serial robot. Direct Kinematics: forward solutions for Stanford and PUMA robots, Inverse Kinematics: inverse (back) solution by Geometric approach with co-ordinate transformation and manipulation of symbolic T and A matrices.

Unit 3
Wheeled mobile robots: Kinematic models of holonomic and non-holonomic mobile robots, modeling of slip. Introduction to ROS.
Case Study: Application of modern control systems on wheeled mobile robots: Navigation of differential drive mobile robots, Software simulation and hardware demonstration.

TEXT BOOKS/ REFERENCES:

"A Mathematical Introduction to Robotic Manipulation", Richard Murray, Zexiang Li and S. Shankar Sastry,2015
Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle "Process Dynamics and Control", John Wiley & Sons, 2015.
Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 2012.
Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 5th edition, 2014.
Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.
W. Bolton, "Mechatronics", Pearson, 6th Edition, 2015.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE355	MECHATRONICS	L-T-P-C: 3-0-0-3

Pre-requisites: Control systems

Course Objective: To integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems by using the concepts of instrumentation.

Course Outcome:

CO1: Understanding of fundamentals of sensors and actuators for mechatronic system
CO2: Ability to develop the mathematical models for dynamic systems
CO3: Ability to design controllers for mechatronic systems
CO4: Exposure to applications of mechatronic systems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	1	1	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Mechatronics, sensors and transducers: Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Displacement, Potentiometer LVDT , Encoders, Hall Effect, Capacitive Transducers, Microprocessor based Controllers - Applications. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, (thermistor, thermocouple) Light Sensors – Selection of Sensors.

Unit 2
Actuation systems: Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and Pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors - Servomotors.
System models and controllers: Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

Unit 3
Programming logic controllers: Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift
Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC Problem – Application of PLCs for control.
Design of mechatronics system: Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Possible Design Solutions. Case Studies of Mechatronics Systems, Pick and place robot – Automatic Car Park Systems – Automatic Camera – Automatic Washing Machine - Engine Management Systems.

Text Book(s)/Reference(s)

Bolton, W. "Mechatronics", Pearson Education, 4th Edition, 2008.
'Mechatronics', HMT Ltd., Tata McGraw Hill Publication Co. Ltd., New Delhi, 5th Edition, 2009.
Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2005.
Ramachandran, K.P., Vijayaraghavan, G.K.and Bala Sundaram, M.S. "Mechatronics: Integrated Mechanical Electronic System" Wiley India Pvt Ltd.
Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.
Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE358	ADVANCED MICROCONTROLLERS	L-T-P-C: 2-0-3-3

Pre-requisites: Micro controllers and Applications

Course Objective

To acquire the knowledge of implementation of real world applications through programming of advanced microcontrollers.

Course Outcome

CO1: Understanding of concepts of advanced microcontrollers
CO2: Ability to program dsPIC/MSP430 microcontroller.
CO3: Design dsPIC/MSP430 based system for various applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
dsPIC 30F series DSC: Introduction to 16 bit microcontrollers- dsPIC 30F DSC – CPU, Data memory, Program Memory- Instruction set- Programming in Assembly and C. Lab practice: Familiarisation of dsPIC programming environment.

Unit 2
Peripherals of dsPIC 30F DSC: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, QEI, 10 bit A/D Converter, UART, CAN Module. Lab practice: Programming and simulation of dsPIC peripherals using dsPIC programming environment. Identify energy efficient entities used in illumination Engineering

Unit 3
MSP430 and peripherals: MSP430f2274- MSP430X22X2 device pin out, DA Package, Functional Block diagram description, Inputs, Outputs, Timers, ADC.

TEXTBOOKS/REFERENCES
dsPIC30F Family Reference manual, Microchip 2008
dsPIC30F Programmer's Reference manual, Microchip 2008
Chris Nagy, "Embedded System Design using the TI MSP 430 series", First Edition. Newnes, 2003
Digital signal Processing Implementations using DSP microprocessors with examples from TMS320C54XX , by Avtar Singh,and S.Srinivasan
Digital Signal Processors by B.Venkat Ramani and Bhaskar
MSP430f2274, Reference Manual, Texas Instruments.- www.ti.com

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE362	DEEP LEARNING FOR VISUAL COMPUTING	L-T-P-C: 3-0-0-3

Pre-requisites: Machine Learning and soft computing

Course Objective

To expose to deep learning concepts and apply them for visual computation purposes.

Course Outcome
CO1: Understanding of visual computing and Neural networks
CO2: Exposure to convolutional Neural networks and very deep CNN.
CO3: Understanding of computational complexity and transfer learning of a network
CO4: Exposure to Recurrent Neural networks (RNN) for classification

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					-	-	-	-	-	-	-	-	-
CO2	3					-	-	-	-	-	-	-		
CO3	3	2				-	-	-	-	-	-	-		-
CO4	3	2				-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction to Visual Computing and Neural Networks , ANN- Perceptron, Feed forward network, Back propagation algorithm. Activation functions - linear, softmax, tanh, ReLU; error functions. Cost functions, Learning Rate Dynamics, optimization and Computational Complexity. Transfer Learning of a Network.

Unit 2
Introduction to Convolutional Neural Networks (CNN) and LeNet , Convolutional Autoencoders and Deep CNN (AlexNet, VGGNet) , Very Deep CNN for Classification (GoogLeNet, ResNet, DenseNet) .
Autoencoders, Autoencoders for Representation Learning and MLP Initialization , Stacked, Sparse, Denoising Autoencoders and Ladder Training . Object Localization (RCNN) and Semantic Segmentation.

Unit 3
Generative Models with Adversarial Learning , Recurrent Neural Networks (RNN) for Video Classification, LSTM for image /video analysis.

Reference/Textbook:
1. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", MIT Press, 2016.

S. Haykin, "Neural Networks and Learning Machines",Third Edition,Pearson, 2008
2. Aditi Majumder (Author), M. Gopi (Author), Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing, CRC Press; 1 edition, 2018.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE363	DIGITAL SYSTEM DESIGN WITH FPGA	L-T-P-C: 3-0-0-3

Pre-requisite: Digital System Design

Course Objective

To provide understanding of digital system design using FPGA.

Course Outcomes

CO1: Understanding of complex digital logic circuits and its design issues
CO2: Ability to model, simulate, verify and synthesize with hardware description languages
CO3: Ability to comprehend the different types of FPGA architecture and its components.
CO4: Exposure to essentials of FPGA based implementation of digital circuits.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1											
CO2	3	2	2	2	3									
CO3	3													
CO4	3	1	1											

Syllabus

Unit 1
Digital system Design - Top down Approach to Design, Case study,Data Path, Control Path, Controller behavior and Design, Case study Mealys & Moore Machines, Timing of sequential circuits, Pipelining, Resource sharing, FSM issues (Starring state, Power on Reset, State diagram optimization, State Assignment,Asynchronous Inputs, Output Races, fault Tolerance.).

Unit 2
VHDL for Synthesis - Introduction, Behavioral, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inferencing, Test bench.

Unit 3
Digital FPGA's - Introduction, Logic Block Architecture, Routing Architecture,
Programmable Interconnections, Design Flow, Xilinx Virtex-II (Architecture),
Boundary Scan, Programming FPGA's - Constraint Editor, Static Timing Analysis, One hot encoding, Applications. Tools, Case Study. Xilinx Virtex II Pro, Embedded System on Programmable Chip, Hardware-software co-simulation, Bus function models, BFM Simulation, Debugging FPGA Design, Chipscope Pro.

References/Textbooks

Jon F Wakerly, Digital Design: Principles and Practices, Prentice Hall,Fourth Edition, 2005.
Kevin Skahil, VHDL for programmable logic, Addison Wesley, Second Edition, 2011.
Zainalabedin Navabi, VHDL, analysis and modeling of digital systems, McGraw-Hill, Second Edition, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

Advanced Computer Technologies

19CSE349	VIRTUAL REALITY	L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming I & II

Course Objective

To understand virtual reality concepts and study of relevant mathematical modeling and software.

Course Outcome

CO1: Understanding on geometric modeling and virtual environment
CO2: Learning on virtual hardware and software
CO3: Ability to develop virtual reality applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	3	-	-	-	-	-	-	-	3	-
CO2	3	-	-	1	3	-	-	-	-	-	-	-	3	-
CO3	3	1	3	1	3	-	-	-	-	-	-	-	3	1

Syllabus

Unit 1
Introduction to Virtual Reality - Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Hlumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit 2
Geometric Modelling - Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems. Virtual Environment - Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Non-linear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system.

Unit 3
Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft. VR Hardware and Software - Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR_ toolkits, Introduction to VRM.

Text books/References

John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2™ Edition, 2006.
William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE364	BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Pre-requisites : Data Structures and Algorithms

Course Objective

To introduce to the core concepts of handling and analyzing big data and different large scale data storage technologies and data streaming platforms.

Course Outcomes

CO1: Understanding of terminologies and core concepts of big data problems and applications
CO2: Understanding of common data structure frameworks
CO3: Exposure to large scale data storage technologies and big data streaming platforms

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-				-	-	-	-	-	-	-	-	-
CO2	3	1				-	-	-	-	-	-	-	-	-
CO3	3	1				-	-	-	-	-	-	-	1	1

Syllabus:

Unit 1
Introduction to bigdata, Challenges with Big data, Big data enabling technolgies, Hadoop stack for bigdata, RDBMS vs Hadoop, hadoop distributed file system (HDFS), hadoop MapReduce 1.0, Hadoop MapReduce 2.0 (Part-I), YARN architecture, MapReduce Examples, Parallel Programming with spark, Introduction to Spark, Spark Built-in-Libraries, Design of Key-Value Stores, Pig on Hadoop.

Unit 2
Data Placement Strategies, CAP Theorem, Consistency Solutions, Design of Zookeeper, CRUD operations, CQL (Cassandra Query Language), Design of HBase, Spark Streaming and Sliding Winode Analytics, Spark Steaming, Sliding window Analytics, Introduction to Kafka, Big Data machine learning, Machine learning Algorithm K-means using Map Reduce for Big Data Analytics, Parallel K-means using Map Reduce on Big Data Cluster Analysis.

Unit 3
Decision Trees for Big Data Analytics, Big Data Predictive Analytics, Parameter Servers, PageRarnk Algorithm in Big Data, Spark GraphX and Graph Analytics, Case study.

TEXT BOOK:
1. Seema Acharya, Subhashini Chellappan , “Big Data and Analytics”, Wiley Publication, 2015.

REFERENCES:

Judith Hurwitz,Alan Nugent, Dr.Fern Halper, Marcia Kaufman , "Big Data for Dummies", John Wiley & Sons, Inc., 2013.
Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach ", Pearson Education, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE447	CLOUD COMPUTING	L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming I

Course Objectives

To understand the basics of cloud computing technology and get exposed to commercial cloud computing services.

Course Outcomes

CO1: Understanding the basic concepts related to cloud computing technologies
CO2: Familiarize with architecture of different cloud services and deployments models
CO3: Introduce to virtualization in cloud computing and various virtualization platforms
CO4: Learn how to use various cloud computing platforms like AWS, Google etc

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-
CO2	3	-	1	-	3	-	-	-	-	-	-	-	3	-
CO3	3	-	1	1	3	-	-	-	-	-	-	-	3	-
CO4	3	2	2	1	3	-	-	-	-	-	-	-	3	-

Syllabus

Unit 1
Introduction to cloud computing:- Evolution of cloud computing, Definition of cloud computing, NIST reference model, Service delivery model, Deployment models, Benefits and challenges of cloud adoption, Introduction to popular cloud platforms,

Unit 2
Virtualization and Cloud Computing Architecture: Introduction - Characteristic of Virtualized Environments – Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing – Technology Examples. Containers: Docker, Linux containers

Unit 3
Distributed computing and cloud- Application of cloud computing: IoT, BigData. Scientific Applications – Business and Consumer Applications - Third Party Cloud Services. Security and privacy issues. Cloud-centric regulatory compliance issues and mechanisms.

Text Book
Anthony T Velte, "Cloud Computing: A practical Approach", Tata McGraw Hill, 2009.

Reference(s)

Rajkumar Buyya, Christian Vecchiola and ThamariSelvi S, "Mastering in Cloud Computing", McGraw Hill Education (India) Private Limited, 2013.
Halper Fern, Kaufman Marcia, Bloor Robin and Hurwit Judith, "Cloud Computing for Dummies", Wiley India, 2009.
Michael Miller, "Cloud Computing", Pearson Education, New Delhi, 2009.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE448	BLOCKCHAIN	L-T-P-C: 3-0-0-3

Course Objective

To understand the fundamentals of crypto currency and application of block chain in implementing crypto currency.

Course Outcomes

CO1: Understanding on the concepts of crypto currency, block chain, and distributed ledger technologies.
CO2: Ability to analyze the application and impact of block chain technology in the financial and other industries
CO3: Ability to evaluate security issues relating to block chain and crypto currency
CO4: Ability to design and analyze the impact of block chain technology

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-
CO2	3	3	2	1	3	-	-	-	-	-	-	-	3	-
CO3	3	3	2	1	3	-	-	-	-	-	-	-	3	1
CO4	3	3	2	2	3	-	-	-	-	-	-	-	3	1

Syllabus

Unit 1
The story of a transaction: From Transactions to Blocks -Blocks and Distributed Consensus - Basic interaction with a Bitcoin node. Keys and Addresses: Basic cryptography - From private keys to addresses. The Bitcoin Script language: Introduction to the Bitcoin Script language - Script writing and execution -Tools and libraries to access Bitcoin's API and scripting capabilities.

Unit 2
Blockchain deployment: Mining and forking - Upgrading the network - Related BIPs - Segregated Witness (SegWit). Blockchain architectures: Abstract Architecture - Ways to dive deeper - Introduction to major blockchain platforms. Smart contracts and Ethereum: Technical introduction to smart contracts - Ethereum overview - Web3 proposition for a decentralized internet - Using Ethereum sub-protocols, storage and ways of interacting with the external world.

Unit 3
Comparing Bitcoin and Ethereum - Historical comparison - Conceptual distinction between a payment system and a decentralized applications platform - Differences in their architectures from security-first aspect to a rich feature set - Future roadmap for them, following their own paths with probable interconnections. Contract code walk-through: Demonstration of smart contract -Introduction to Solidity - Contract lifecycle - Solidity Building blocks - Popular contracts already in deployment.

Textbook(s)/ Reference(s)

Mastering Bitcoin Andreas Antonopoulos O'Reilly Publishing 2014 978-0691171692.
Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press (July 19, 2016)
William Mougayar. The Buisness Blockchain: Promise, Practice, and Application of the Next Internet Technology. Wiley; 1st edition (May 9, 2016)
Bitcoin: A Peer-toPeer Electronic Cash System Satoshi Nakamoto Online 2009 https://bitcoin.org/bitcoin.pdf
Vitalik Buterin Ethereum White Paper Online 2017

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE449	MOBILE APPLICATIONS AND DEVELOPMENT	L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming I

Course Objective

To introduce basics and techniques of application development in smart phone operating systems such as Android.

Course Outcome

CO1: Understanding of Android programming
CO2: Ability to integrate mobile applications with cloud services
CO3: Familiarize with various services and its usage

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	3	-	-	-	-	-	-	-	-	-
CO2	3	1	3	1	3	-	-	-	-	-	-	-	-	3
CO3	3	1	3	-	3	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Introduction to mobile application development platforms, Application development-Layouts, Views, Resources, Activities, Intents, Background tasks, Connecting to the Internet, Fragments, Preferences.

Unit 2
User Interaction – input, menu items, custom views, User Experience – themes and styles, lists and adapters, material design, adaptive layouts, accessibility, localization, debugging the UI Storing Data, SQLite database, Sharing Data, content resolvers and providers, loaders to load data.

Unit 3
Services, background work, alarms, broadcast receivers, Notification, widgets, location based services and Google maps. transferring data efficiently, publishing app, Multiple form factors, sensors, Google cloud messaging, monetizing mobile app.

Textbook/Reference
Android Programming (Big Nerd Ranch Guide), by Phillips, Stewart, Hardy and Marsicano
Android Programming – Pushing the limits by Hellman
Mobile Computing - NPTEL Prof. Pushpendra Singh Department of Computer Science and Engineering IIITD.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE450	QUANTUM COMPUTING	L-T-P-C: 3-0-0-3

Course Objective

Develop quantum computing algorithms and learn programming models.

Course Outcome

CO1: Understanding on quantum computing and building blocks for quantum program
CO2: Learning on programming model for a quantum computing program
CO3: Ability to build quantum algorithms for standard scenarios.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	-	-	-	-	3	-
CO2	3	2	2	1	3	-	-	-	-	-	-	-	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Introduction to Quantum Computing: Motivation for studying Quantum Computing, Major players in the industry (IBM. Microsoft, Rigetti. D-Wave etc.), Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bra-ket notation. Bloch Sphere representation, Quantum Superposition, Quantum EntanglementMath Foundation for Quantum Computing:Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.

Unit 2
Building Blocks for Quantum Program: Architecture of a Quantum Computing platform, Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates., Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift. Controlled gates, Ising, Deutsch, swap etc.Programming model for a Quantum Computing Program: Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.

Unit 3
Quantum Algorithms- Basic techniques exploited by quantum algorithms: Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks.Major Algorithms: Shoe’s Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm. OSS Toolkits for implementing Quantum program: IBM Quantum Experience, Microsoft Q, Rigetti PyQuil(QPU/QVM)

Text Book/ References

Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press, Tenth Edition, 2010
David McMahon, "Quantum Computing Explained", Wiley, First Edition,2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE468	WEB TECHNOLOGIES AND APPLICATIONS	L-T-P-C: 3-0-0-3

Course Objective

To introduce to client server architecture and derive ability to develop a web application using Java technologies.

Course Outcomes

CO1: Ability to apply the concepts of responsive web design to customize pages for users demand.
CO2: Ability to apply markup and scripting languages to design and validate dynamic web pages.
CO3: Ability to evaluate the appropriateness of client/server applications.
CO4: Ability to evaluate the appropriateness of client/server applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	2	3	-	-	-	-	-	-	-	-	-	-
CO4	3	2	3	-	1	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Web essentials : Creating a Website – Working principle of a Website – Browser fundamentals – Authoring tools – Types of servers: Application Server – Web Server – Database Server; Scripting essentials : Need for Scripting languages – Types of scripting languages – Client side scripting

Unit 2
Server side scripting – PHP – Working principle of PHP – PHP Variables – Constants – Operators – Flow Control and Looping – Arrays – Strings – Functions – File Handling – PHP and MySQL – PHP and HTML – Cookies – Simple PHP scripts. XML-Documents and Vocabularies-Versions and Declaration-Namespaces- DOM based XML processing Event-oriented Parsing: XML-Documents and Vocabularies-Versions and Declaration-Namespaces-DOM based XML processing Event-oriented Parsing

Unit 3
Application essentials: Creation of simple interactive applications – Simple database applications – Multimedia applications – Design and development of information systems – Personal Information System – Information retrieval system – Social networking applications.

Textbook(s)
Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014.

Reference(s)

Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 2006.
Robert. W. Sebesta, "Programming the World Wide Web", Fourth Edition,Pearson Education, 2007 .
Bates, ―Developing Web Applications‖, Wiley, 2006
R. Kelly Rainer, Casey G. Cegielski, Brad Prince, Introduction to Information Systems, Fifth Edition, Wiley Publication, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

GENERAL ELECTIVES

19EEE201	ELECTROMAGNETIC THEORY	L-T-P-C: 3-0-0-3

Course Objective

To introduce different coordinate systems, concepts of electrostatic, magneto static and time varying electromagnetic fields.

Course Outcome

CO1: Understanding of coordinate systems, conversions and governing laws of Electric and Magnetic fields.
CO2: Ability to analyze Electric and Magnetic field distributions using Maxwell's equations.
CO3: Ability to evaluate electromagnetic and electrostatic fields in scalar and vector forms.
CO4: Ability to formulate Travelling Waves in different media.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Vectors and co-ordinate systems: - Cartesian, cylindrical and spherical co-ordinate systems- scalar and vector fields. Electric and Magnetic fields: - line, surface and volume integrals- Coulomb's law- Gauss's law- Biot-Savart's law- Ampere's circuital law- applications- boundary conditions for electric and magnetic fields- Lorentz force equation.

Unit 2
Maxwell's equations: - gradient, curl and divergence- Maxwell's equation in integral form- Law of conservation of charge- Maxwell's equation in differential form- continuity equation- boundary condition for electromagnetic fields. Electric potential- Poisson's and Laplace's equations- capacitance- energy stored- magnetic scalar and vector potentials- magnetic circuits- inductance- energy stored- conductance.

Unit 3
Uniform plane waves and sinusoidally varying waves in time domain and in free space- polarization- power flow and Poynting vector- wave parameters- plane waves in material media- skin effect- reflection and transmission of uniform plane waves- normal and oblique incidence in conductor and dielectric interfaces.
Virual lab platforms /simulation demos/ animated videos can be used for effective classroom teaching.

Text Book
1.N.Narayana Rao, "Elements of Engineering Electromagnetics", Sixth Edition, Pearson Education, 2006.

Reference(s)

David.K.Cheng, "Field and Wave Electromagnetics", Second Edition, Pearson Education, 2002.
William H.Hayt, John.A.Buck, "Engineering Electromagnetics", Seventh Edition, Tata 3. McGraw Hill. Publishing Company Limited, 2007.
Sadiku, "Elements of Electromagnetics", Second Edition, Oxford University press. 2007.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE440	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-0-0-3

Pre-requisites: Information Technology Essentials

Course Objective

To study different network topologies and learn MANET and WSN implementation and application in networked systems.

Course Outcome

CO1: Understanding on Adhoc and wireless sensor networks and their applications
CO2: Knowledge on design, coverage, placement and topology management of nodes in wireless sensor networks
CO3: Exposure on protocols and operation of wireless sensor networks .
CO4: Ability to evaluate applications and security of wireless sensor networks.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	1	1	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	1	-	-	-	-	-	2	2

Syllabus

Unit 1
Introduction: Wireless Ad-Hoc networks – self organizing behaviour – cooperation in mobile Ad-Hoc network.MAC protocols in MANETs – Routing in MANETs – Multicasting in MANETs – Transport Protocols for MANETs.

Unit 2
Opportunistic mobile networks – UAV networks – Wireless sensor networks. WSN coverage and placements – topology management in wireless networks – mobile wireless sensor networks – medium access control in wireless networks – routing in wireless sensor networks.

Unit 3
Congestion and flow control – underwater sensor networks – security of wireless sensor networks – hardware design of sensor node – real life deployment of WSN.
Case study/ Real life deployment of WSN.

Textbooks/References:
Zhao and L. Guibas, "Wireless Sensor Networks", Morgan Kaufmann, San Francisco, 2004
C. S. Raghavendra, K.M.Shivalingam and T.Znati, "Wireless Sensor Networks", Springer, New York, 2004
Anna Hac, "Wireless Sensor Network Designs", John Wiley & Sons, 2004.
Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Inter Science, 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE442	OPTO-ELECTRONICS & LASER INSTRUMENTATION	L-T-P-C: 3-0-0-3

Course objective

To introduce concepts of optical transmission and laser technologies and its application in industry and medical field**.**

Course Outcome

CO1: Understanding on fundamental concepts of optical sources, transmission and photo detection
CO2: Familiarity with basic concepts of optical fibers and their properties.
CO3: To introduce to laser characteristics and generation
CO4: Ability to apply laser technologies to industrial and medical applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Introduction - Characteristics of optical radiation, luminescence, irradiance - Optical Sources - Photo Detectors - Opto-couplers and their application in analog and digital devices. Optical Fiber Fundamentals - modes, types of optical fibers - fiber coupling - Fiber optic sensors for common industrial parameters - V, I, pressure, temperature - IR sources and detectors - fiber optic gyroscope.

Unit 2
Characteristics of LASERS - Einstein's equations - population inversion two, three and four level system. Laser rate equation, properties – modes - Resonator configurations - Q switching and mode locking, cavity dumping, single frequency operation - Types of Lasers. Applications - Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, pollutants.

Unit 3
Material processing applications - Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporization.
Holographic Interferometry and Applications – Holography for non-destructive testing – medical applications - lasers and tissue interaction -surgery – dermatology

Text Book(s)
Wilson and Hawkes, "Opto Electronics-An Introduction", Third Edition, Pearson Education, 1998.
John Ready, "Industrial Applications of Lasers", Second Edition, Academic Press, 1997

Reference(s)

Bhattacharya P, "Semiconductor Optoelectronics", Second Edition, Pearson Education, 1998.
Djafar K. Mynbaev, Lowell L. Scheiner, "Fiber-Optic Communications Technology", First Edition, Prentice Hall of India Pvt. Limited, 2000.
R. P. Khare, "Fiber Optics and Optoelectronics", Oxford Press, 2004

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE444	ELECTROMAGNETIC COMPATIBILITY	L-T-P-C: 3-0-0-3

Pre-requisites: Electro Magnetic Theory

Course Objective

To introduce the concepts of electromagnetic interference and electromagnetic compatibility and to analyze the different EM coupling principles and its impact

Course Outcomes

CO1: Understanding of requirement of EMI and EMC
CO2: Ability to investigate the features of electromagnetic interferences.
CO3: Exposure to various methods to prevent electromagnetic interferences
CO4: Knowledge on electromagnetic interferences standards, specifications and test methods

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2												
CO3	3	1												
CO4	3	1												

Syllabus

Unit 1
Review of electromagnetic principles: Maxwell's equations, plane waves, transmission lines. Introduction to Finite Element method, Introduction to electromagnetic compatibility, sources of EMI, Transient EMI, Basic definitions of EMC .

Unit 2
EMI Coupling Principles, Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Crosstalk, EMI Control Techniques - Shielding, Grounding, Bonding.

Unit 3
Radiated Common Mode and Ground Loop Coupling, EMI Test Instruments, Various Test Methods and Calibration Procedures, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting Units, EMI Specifications, Civilian & Military Standards.

Text Book
C.R. Paul, "Introduction to Electromagnetic Compatibility", John Wiley and Sons, (Wiley Series in Microwave and Optic Engineering), 2006.

Reference(s)

Henry W Ott, "Electromagnetic Compatibility Engineering", John Wiley, 2009
Berhard Keiser, "Principles of Electromagnetic Compatibility", Artech House, 3rd Edition, 1995
V.P.Kodali, " Engineering EMC Principles , Measurements and Technologies," IEEE Press,1996
Course Material on Electromagnetic Compatibility, Rajeev Thottappillil, Professor, Electromagnetic Engineering, KTH Royal Institute of Technology, Stockholm.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE445	ILLUMINATION ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

To introduce to the fundamentals of illumination engineering and design.

Course Outcomes

CO1: Understanding of characteristics of visible light spectrum and principles of optics.
CO2: Ability to design lighting schemes for various applications.
CO3: Ability to evaluate the performance of various lighting designs.
CO4: Expose to building codes and control schemes of lighting design.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2	1											
CO3	3	2												
CO4	3	2				1							1	

Syllabus

Unit 1

Radiant energy and visible spectrum, energy conversion to light, colour, eye and vision; different entities of illuminating systems. Energy efficient illuminating system components: Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps, lasers, LED and CoB LED; Factors affecting lighting-shadow, glare, reflection, Luminaries, wiring, switching and control circuits.

Unit 2

Laws of illumination; illumination from point, line and surface sources. Photometry and spectrophotometry; photocells. Environment and glare. Design of indoor lighting system, Illumination levels, loss factors, lamp selection and maintenance. Special feature for entrance, staircase, Corridor lighting and industrial building

Unit 3

Exterior lighting- Design of outdoor lighting system, flood light, street lighting, aviation and transport lighting, lighting for displays and signaling- neon signs, LED-LCD displays beacons and lighting for surveillance. Energy Conservation codes for lighting; lighting controls – daylight sensors and occupancy sensors; controller design, Special Features of Aesthetic Lighting: Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting, Smart Green House lighting.

Text Book

Craig DiLouie, "Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications", CRC Press, 2006

Reference(s)

Kao Chen, "Energy Management in Illuminating Systems", Carlsons Consulting Engineers, San Diego, California, USA, CRC Press, 1999

Mark Stanley Rea, "IESNA Lighting Handbook", Illuminating Engineering Society of North America, 2000

Soni, Gupta and Bhatnagar, "A Course in Electrical Power", Fourth Edition, Dhanpat Rai & Sons, 1996.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE449	3D PRINTING AND DESIGN	L-T-P-C: 3-0-0-3

Course Objective

To impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique.

Course Outcome

CO1: Ability to develop CAD models for 3D printing
CO2: Ability to import and export CAD data and generate .stl file
CO3: Ability to select a specific material and 3D printing process for an application
CO4: Ability to build a product using 3D printing or additive manufacturing (AM)

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	3	-	-	-	-	-	-	-	-	-
CO2	3	-	3	-	3	-	-	-	-	-	-	-	-	-
CO3	3	1	1	2	3	-	-	-	-	-	-	-	1	2
CO4	3	-	-	3	3	-	-	-	-	-	-	-	2	1

Syllabus

Unit 1
3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing, processes, Applications. CAD for Additive Manufacturing. CAD Data formats, Data translation, Data loss, STL. format. Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter. Process Selection for various applications.
Additive Manufacturing Application Domains: Aerospace, Electronics, Health
Care, Defence, Automotive. Construction, Food Processing. Machine Tools

Unit 2
Materials: Polymers, Metals, Non-Metals, Ceramics. Various forms of raw material- Liquid, Solid, Wire, Powder, Powder Preparation and their desired properties, Polymers and their properties. Support Materials. Additive Manufacturing Equipment.

Unit 3
Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design. Post Processing: Requirement and Techniques.
Product Quality: Inspection and testing, Defects and their causes

Text Books/References
Lan Gibson, David W. Rosen and Brent Stucker. "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing". Springer. 2010.
Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping. Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
Khanna Editorial, "3D Printing and Design". Khanna Publishing House. Delhi.
CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.

J.D, Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials". Springer Series in Material Science, 2013.
L. Lu, J. Fuh and Y.S. Wong. "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy". InTech, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE452	FORMAL METHODS	L-T-P-C: 3-0-0-3

Pre-requisites: Data Base Systems and Programming

Course Objective

To understand the application of formal methods in software development and various model checking tools and software.

Course Outcome

CO1: Understanding of formal methods.
CO2: To introduce to different software tools.
CO3: Ability to analyse model-checking algorithms.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	1	1	2	3	-	-	-	-	-	-	-	3	2
CO3	3	1	3	2	3	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Formal Methods: Specification, Analysis, Verification, Importance for Safety Critical Systems, Propositional and Predicate Logic Specification Languages Axiomatic Specifications, Algebraic Specifications, Model-based Specifications Program Verification Floyd-Hoare logic and Dijkstra's Weakest Pre-conditions, Partial Correctness and Termination, Structural induction for Recursive Procedures, Data refinement in Z Abstract Data Types.

Unit 2
Software Tools: PVS, Isabelle. Temporal Logics-Specifying Concurrent Systems: Safety, Liveness, Fairness, Linear (LTL) and Branching Time (CTL) Logics, Translation from LTL-to-Buchi automata Fixed Point Characterization of Temporal Operators. Model Checking-LTL and CTL model-checking.

Unit 3
Analysis of model-checking algorithms Symbolic model checking; overview of state-space reduction methods, Case study and practical verification of properties, Software Tools: SPIN/Promela. Process Algebras: CCS and Pi-calculus, Simulation and Bisimulation Timed Automata for Real-time Systems (UPPAAL)

Textbook(s)/ Reference(s)

Michael Huth and Mark Ryan , "Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press, 2004.
E.M. Clarke, O. Grumberg, and D. Peled, "Model Checking", MIT Press, 2000.
Christel Baier, Joost-Pieter Katoen, "Principles of Model checking", The MIT Press, 2008.
J. Woodcock & J. Davies, "Using Z: Specification, Refinement and Proof", Prentice Hall, 1994.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE453	RF CIRCUIT DESIGN	L-T-P-C: 3-0-0-3

Pre-requisites: Circuit Analysis

Course Objective

To understand the concepts of RF technology and to develop various communication modules and analyze their characteristics.

Course Outcome

CO1: Understanding on passive and active RF components.
CO2: Ability to develop device models and characteristics.
CO3: Ability to analyze RF amplifiers and high frequency amplifiers.
CO4: Ability to evaluate low noise amplifiers and mixers.
CO5: Ability to create RF oscillators and phase locked loops.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	-	-	-	-	1	-	-	-	-	-

Syllabus

Unit 1
Introduction: RF systems–basic architectures, Transmission media and reflections, Maximum power transfer, Passive RLC Networks: Parallel RLC tank, Q, Series RLC networks, matching, Pi match, T match, Passive IC Components: Interconnects and skin effect, Resistors, capacitors Inductors. Review of MOS Device Physics-MOS device review, Distributed Systems, Transmission lines, reflection coefficient, the wave equation, examples, Lossy transmission lines, Smith charts–plotting Gamma.

Unit 2
High Frequency Amplifier Design: Bandwidth estimation using open-circuit time constants, and short-circuit time constants, Rise time, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers. Noise -Thermal noise, flicker noise review, Noise figure, LNA Design: Intrinsic MOS noise parameters, , large signal performance, design examples & Multiplier based mixers. Mixer Design, Subsampling mixers.

Unit 3
RF Power Amplifiers, Class A, AB, B, C amplifiers, Class D, E, F amplifiers, RF Power amplifier design examples, Voltage controlled oscillators: Resonators, Negative resistance oscillators, Phase locked loops: Linearized PLL models, Phase detectors, charge pumps, Loop filters, and PLL design examples. Frequency synthesis and oscillators: Frequency division, integer-N synthesis, Fractional frequency, synthesis, Phase noise, General considerations, and Circuit examples, Radio architectures: GSM ,CDMA, UMTS radio architectures.

Text books/ References

RF Microelectronics by Behzad Razavi. Prentice Hall,2013

The Design of CMOS Radio-Frequency IntegratedCircuits by Thomas H. Lee. Cambridge University Press,2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE454	SOFTWARE ENGINEERING	L-T-P-C: 3-0-0-3

Course Objective

To impart knowledge of basic software engineering methods and practices, implementation of issues and their application.

Course Outcomes

CO1: Understanding the principles of software engineering and various software process models
CO2: Ability to apply software design methodology for a given scenario
CO3: Ability to evaluate a system developed for real-world applications in Agile Mode
CO4: Familiarize with various industry standards

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	1	-	-	-
CO2	3	1	3	-	2	-	-	1	2	-	-	-	-	-
CO3	3	2	3	-	3	-	-	-	2	1	2	-	-	-
CO4	3	-	-	-	-	-	-	1	-	-	-	-	-	-

Syllabus

Unit 1
Process Models – overview, Introduction to Agile, Agile Manifesto, principles of agile manifesto, over-view of Various Agile methodologies - Scrum, XP, Lean, and Kanban, Agile Requirements - User personas, story mapping, user stories, estimating and prioritizing stories, INVEST, acceptance criteria, Definition of Done, Release planning Key aspects of Scrum: roles - Product Owner, Scrum Master, Team, Manager in scrum and product backlog Scrum process flow: product backlog, sprints backlog, scrum meetings, demos. How sprint works: Sprint Planning, Daily scrum meeting, updating sprint backlog, Burn down chart, sprint review, sprint retrospective. Scrum Metrics- velocity, burn down, defects carried over.

Unit 2
Traditional process Models: Waterfall, incremental, evolutionary, concurrent. Requirements Engineering: Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model-Negotiation- Validation Requirements Modelling - building the analysis model, Scenario based methods, UML Models, Data Models. Design engineering Design concepts, Design models, software architecture, architectural styles and patterns, Architectural design: styles and patterns, architectural design, Refining architecture to components. Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps.

Unit 3
Testing strategies and tactics: Unit testing, integration testing, validation and system testing, Devops.

TextBook

Pressman R S, Bruce R.Maxim, Software Engineering - A Practitioner's Approach. Eighth Edition, McGraw-Hill Education, 2019.

Reference(s)

Crowder JA, Friess S. Agile project management: managing for success. Cham: Springer International Publishing; 2015.
Stellman A, Greene J. Learning agile: Understanding scrum, XP, lean, and kanban. " O'Reilly Media, Inc."; 2015.
Gregory J, Crispin L. More agile testing: learning journeys for the whole team. Addison-Wesley Professional; 2015.
Rubin KS. Essential Scrum: a practical guide to the most popular agile process. Addison-Wesley; 2012.
Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and

19MNG331	FINANCIAL MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

To introduce to the financial planning and budgeting techniques.

Course Outcomes

CO1: Understanding of the rationale of finance planning and budgeting.
CO2: Ability to estimate financial requirement, cost of capital and values of bonds and shares
CO3: Exposure to capital budgeting & risk analysis.
CO4: Knowledge on techniques of working capital management, cash management, inventory management, receivable management and dividend decision.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2												
CO4	3	2												

Syllabus

Unit 1
Financial Management: Introduction, Definitions, Goals, Functions, Interface between Finance and Other Business Functions. Financial Planning: Objectives, Benefits, Steps in Financial Planning, Factors affecting financial Planning, Estimation of Financial Requirements of a Firm, Capitalization, Time Value of Money, Valuation of Bonds and Shares. Cost of Capital: Cost of Different Sources of Finance, Weighted Average Cost of Capital.

Unit 2
Leverage: Operating Leverage, Financial Leverage, Combined Leverage, Applications. Capital Structure: Ideal Capital Structure, Factors Affecting Capital Structure, Theories of Capital Structure. Capital Budgeting: Capital Budgeting Decisions, Phases of Capital Expenditure Decisions, Identification of Investment Opportunities, Rationale of Capital Budgeting Proposals, Capital Budgeting Process, Investment Evaluation, Risk Analysis in Capital Budgeting, Capital Rationing, Various Approaches to Capital Rationing.

Unit 3
Working Capital Management : Components of Current Assets and Current Liabilities, Concepts of Working Capital, Operating Cycle, Determinants, Estimation and management of Working Capital. Cash Management: Objectives, Models for Determining Optimal Cash Needs, Cash Planning, Cash Forecasting and Budgeting. Inventory Management: Introduction, Role of Inventory in Working Capital, Characteristics of inventory, Inventory Management Techniques. Receivable Management: Costs Associated with Maintaining Receivables, Credit Policy Variables, Evaluation of Credit Policy. Dividend Decisions: Traditional Approach, Stability of Dividends, Forms of Dividends, Stock Split.

Textbook/Reference(s)

Khan M.Y and.Jain P.K, Financial Management, Text, Problems and Cases - Tata McGraw Pandey I.M , Financial Management, Vikas Publishing House Pvt. Ltd.,

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and

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Course Objective

To introduce various optimization methods applicable to engineering systems.

Course Outcome

CO1: Understanding of the logics of various optimization techniques.
CO2: Ability to formulate and solve optimization problems.
CO3: Ability to interpret and analyze the solutions of optimization algorithms.
CO4: Ability to use software tools in engineering design optimization problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	**PSO2**
CO1	3	1		-	-	-	-	-	-	-	-	-	-	-
CO2	3	3		1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO4	3		1	-	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction: Optimization – optimal problem formulation, engineering optimization problems, optimization algorithms, numerical search for optimal solution. graphical method, simplex method, Big M method, Two phase method.

Unit 2
Single variable optimization: Optimality criteria, bracketing methods- exhaustive search method, bounding phase method- region elimination method-interval halving, fibanacci search, golden section search, interpolation methods, point estimation method- successive quadratic search, gradient based method. Initial value problems for ordinary differential equations: single step methods, Taylor series method, Euler and modified Euler methods, fourth order Runge – Kutta method for solving first and second order equations. Case study and Simulation.

Unit3
Multivariable optimization: Optimality criteria, unconstrained optimization- solution by direct substitution unidirectional search- direct search methods, simultaneous uni-directional method- steepest descent method, shortest path algorithm Hook- Jeeves pattern search method, gradient based method. Newton's method, Conjugate gradient method, constrained optimization-Kuhn- Tucker, Lagrange multiplier method. Case Studies and simulation

Stochastic methods of optimization: random search methods, evolutionary computation-Introduction, Survival of the Fittest, Fitness Computation, Cross over, Mutation, Reproduction, Particle Swarm Optimization, Introduction to Multi-objective optimization. Case study and Simulation.

Text Book/ Reference(s)

S. S. Rao, "Optimization Theory & Applications", New Age international ltd. Publishers, Second edition, 1995
Kalyanmoy Deb, "Optimization for Engineering Design Algorithms & Examples" Prentice Hall of India, NewDelhi 2004.
Edwin K. P. Chong, and Stanislaw H. Zak, "An Introduction to optimization", Wiley- interscience series in discrete mathematics and optimization, second edition, 2004.
M. Asghar Bhatti, "Practical optimization methods with mathematics applications", Springer Verlag Publishers, 2000.
G. A Vijayalakshmi Pai & S. Rajashekharan " Neural Network, Fuzzy Logic, Genetic Algorithms Synthesis & Applications", PH India,2003.

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*CA – Can be Quizzes, Assignment, Projects, and