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Semester VII (Fourth Year]
Branch/Course Civil Engineering

Course Code	Course Title	L	T	P	Credits	Branch			
100705	Graduate Employability Skills and Competitive Courses (GATE, IES, etc.)	3	0	0	0	101	TH	0	0
1017xx	Open Elective- I	3	0	0	3	101	TH	70	30
101701	Professional Practice, Law & Ethics	2	0	0	2	101	TH	70	30
1017xx	Program Elective - III	3	0	0	3	101	TH	70	30
1017xx	Program Elective- II	3	0	0	3	101	TH	70	30
100709	Project-I	0	0	12	6	101	PR	30	20
100707	Summer Entrepreneurship - III	0	0	16	8	101	PR	30	20

Semester VII (Fourth Year]
Branch/Course Mechanical Engineering

Course Code	Course Title	L	T	P	Credits	Branch			
100701	Induction Program	3	0	0	0	102	TH	0	0
102701	Internal Combustion Engines	3	0	0	3	102	TH	70	30
1027xx	Open Elective- II	3	0	0	3	102	TH	70	30
1027xx	Program Elective - III	3	0	0	3	102	TH	70	30
1027xx	Program Elective- IV	3	0	0	3	102	TH	70	30
102701	Internal Combustion Engines	0	0	3	1.5	102	PR	30	20
100709	Project-I	0	0	12	6	102	PR	30	20
100702	Summer Entrepreneurship-III	0	0	16	8	102	PR	30	20

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Semester VII (Fourth Year]
Branch/Course Electrical Engineering

Course Code	Course Title	L	T	P	Credits	Branch			
103702	Human Values & Ethics	3	0	0	0	103	TH	0	0
1037xx	Open Elective- I	3	0	0	3	103	TH	70	30
1037xx	Open Elective- II	3	0	0	3	103	TH	70	30
103701	Power System Protection	3	0	0	3	103	TH	70	30
1037xx	Program Elective- IV	3	0	0	3	103	TH	70	30
100709	Project-I	0	0	12	6	103	PR	30	20
100706	Seminar	0	0	2	1	103	PR	30	20
100702	Summer Entrepreneurship-III	0	0	16	8	103	PR	30	20

Semester VII (Fourth Year]
Branch/Course Electronics & Communication Engineering

Course Code	Course Title	L	T	P	Credits	Branch			
104701	Business Analytics	3	0	0	3	104	TH	70	30
104702	Cost Management of Engineering Projects	3	0	0	3	104	TH	70	30
100705	Graduate Employability Skills and Competitive Courses (GATE, IES, etc.)	3	0	0	0	104	TH	0	0
1047xx	Program Elective - III	3	0	0	3	104	TH	70	30
1047xx	Program Elective- II	3	0	0	3	104	TH	70	30
104703	Wireless Communication	3	0	0	3	104	TH	70	30
100709	Project-I	0	0	12	6	104	PR	30	20
100702	Summer Entrepreneurship-III	0	0	16	8	104	PR	30	20

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Semester VII (Fourth Year]
Branch/Course COMPUTER SCIENCE & ENGINEERING

Course Code	Course Title	L	T	P	Credits	Branch			
100708	Biology for Engineers	2	1	0	3	105	TH	70	30
100701	Induction Program	3	0	0	0	105	TH	0	0
1057xx	Open Elective- I	3	0	0	3	105	TH	70	30
1057xx	Open Elective- II	3	0	0	3	105	TH	70	30
1057xx	Program Elective - III	3	0	0	3	105	TH	70	30
100709	Project-I	0	0	12	6	105	PR	30	20
100707	Summer Entrepreneurship - III	0	0	16	8	105	PR	30	20
1057xx	Professional Elective Lab-II	0	0	2	1	105	PR	70	30

Semester VII (Fourth Year]
Branch/Course INFORMATION TECHNOLOGY

Course Code	Course Title	L	T	P	Credits	Branch			
100708	Biology for Engineers	2	1	0	3	106	TH	70	30
100701	Induction Program	3	0	0	0	106	TH	0	0
1067xx	Open Elective- I	3	0	0	3	106	TH	70	30
1067xx	Open Elective- II	3	0	0	3	106	TH	70	30
1067xx	Program Elective - III	3	0	0	3	106	TH	70	30
100709	Project-I	0	0	12	6	106	PR	30	20
100707	Summer Entrepreneurship - III	0	0	16	8	106	PR	30	20
1067xx	Professional Elective Lab-II	0	0	2	1	106	PR	70	30

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Semester VII (Fourth Year]
Branch/Course LEATHER TECHNOLOGY

Course Code	Course Title	L	T	P	Credits	Branch			
107701	Chemical Reaction Engineering	3	0	0	3	107	TH	70	30
107703	Leather Product Technology-II	3	0	0	3	107	TH	70	30
1077xx	Program Elective- I	3	0	0	3	107	TH	70	30
107702	Theory of Leather supplements & Synthetics	3	0	0	3	107	TH	70	30
107704	Workshop/heads on Training/Soft Skill	3	0	0	0	107	TH	0	0
107703	Leather Product Technology-II	0	0	3	1.5	107	PR	30	20
100709	Project-I	0	0	12	6	107	PR	30	20
100707	Summer Entrepreneurship - III	0	0	16	8	107	PR	30	20

Semester VII (Fourth Year]
Branch/Course ELECTRICAL ELECTRONICS ENGINEERING

Course Code	Course Title	L	T	P	Credits	Branch			
1107xx	Open Elective- I	3	0	0	3	110	TH	70	30
1107xx	Open Elective- II	3	0	0	3	110	TH	70	30
1107xx	Program Elective - III	3	0	0	3	110	TH	70	30
1107xx	Program Elective- IV	3	0	0	3	110	TH	70	30
100709	Project-I	0	0	12	6	110	PR	30	20
100706	Seminar	0	0	2	1	110	PR	30	20
100702	Summer Entrepreneurship-III	0	0	16	8	110	PR	30	20

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101701	**Professional Practice, Law & Ethics**	**2L:0T:0P**	**2 credits**

Basic elements of civil engineering professional practice are introduced in this course. Roles of all participants in the process-owners, developers, designers, consultants, architects, contractors, and suppliers - are described. Basic concepts in professional practice, business management, public policy, leadership, and professional licensure are introduced. The course covers professional relations, civic responsibilities, and ethical obligations for engineering practice. The course also describes contracts management, and various legal aspects related to engineering. Further, the course familiarizes students with elementary knowledge of laws that would be of utility in their profession, including several new areas of law such as IPR, ADR.

The course is designed to address the following:
- To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession
- To develop some ideas of the legal and practical aspects of their profession

Proposed Syllabus

Professional practice covering the respective roles of the various stakeholders in the profession of civil engineering and the factors governing the same; Professional ethics relating to civil engineering; Various aspects of contracts relating to construction and management of contracts; types of contractual and other disputes in the profession and methods of dispute resolution; legal aspects relating to employment and service conditions of labour; intellectual property rights and their legal framework

Modules:

Module 1 A- Professional Practice – Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Module 1 B- Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module 2:*General Principles of Contracts Management: Indian Contract Act, 1972 and amendments* covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various

types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /"Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

Module 3 *:Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system:* Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats

Module 4 : *Engagement of Labour and Labour & other construction-related Laws:* Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module 5 : *Law relating to Intellectual property:* Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;

ORGANISATION OF COURSE (2-0-0)

S. No	Module	No of Lectures	Details
1A	Professional Practice	2	
1B	Professional Ethics	2	

2	Contracts Management	18	
3	Dispute Resolution Mechanisms	5	
4	Labour; Labour & other Laws	2	
5	Intellectual Property Management	1	
	TOTAL	**30**	

Text/Reference Books:
1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. RERA Act, 2017
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
5. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
6. Avtarsingh (2002), Law of Contract, Eastern Book Co.
7. Dutt (1994), Indian Contract Act, Eastern Law House
8. Anson W.R. (1979), Law of Contract, Oxford University Press
9. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
12. Bare text (2005), Right to Information Act
13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
14. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act
15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House
16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2,pp 117-127, MCB UP Ltd
17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
18. Ethics in Engineering- M.W.Martin& R.Schinzinger, McGraw-Hill
19. Engineering Ethics, National Institute for Engineering Ethics, USA
20. www.ieindia.org
21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm
23. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html
24. Contract&Agreements http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm
25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
26. Business & Personal Law. Chapter 7. "How Contracts Arise", http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
27. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt

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28. IV.   TYPES   OF   CONTRACTS   AND   IMPORTANT   PROVISIONS,
http://www.worldbank.org/html/opr/consult/guidetxt/types.html   Contract
Types/Pricing   Arrangements   Guideline-   1.4.G   (11/04/02),
http://www.sandia.gov/policy/14g.pdf

102701	Internal Combustion Engines	3L:T:3P	4.5 Credits

Objectives:
1. To familiarize with the terminology associated with IC engines.
2. To understand the basics of IC engines.
3. To understand combustion, and various parameters and variables affecting it in various types of IC engines.
4. To learn about various systems used in IC engines and the type of IC engine required for various applications

Course Contents:

Module:1

Basics of IC Engines, Engine components and classification: Two strokes, four stroke (SI and CI) engines, engines parts, engines working principle and valve timing diagram. Ideal cycles and Fuel-air cycles.   **(Lectures 6)**

Module: 2

Engine performance-test: purpose and types, measurement of power, Engine system & performance parameters evaluation.   **(Lectures 4)**

Module: 3

Combustion in SI and CI engines: Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines, Stages of combustion in CI engines, detonation in C.I. engines, factors affecting detonation, controlling detonation, combustion chamber for SI and CI engine.   **(Lectures 7)**

Module: 4

Fuel supply systems in SI and CI engines, carburetors, Port fuel injection, Direct injection and Common rail injection.   **(Lectures 6)**

Module: 5

Ignition system: Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing.

Lubrication system and Cooling system: Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air cooled systems.   **(Lectures 7)**

Module: 6

Measurement and Testing of IC engines: Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan's Line Method and Morse Test, calculation of brake thermal efficiency, brake power and brake specific fuel

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consumption of IC Engines, variable compression ratio engines, heat balance sheet of IC Engines.

Engine Emission and their control: Air pollution due to IC engines, constituent and types of emission HC, CO and NOx emission, catalytic convertor. Advanced IC Engine concepts.

(Lectures 8)

Module: 7

Super charging, engine lubrication and cooling.   **(Lectures 4)**

Text Books:

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.
2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.
3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.
5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, Wilcox Co.
6. Inc., Illinois, 1996.

Course Outcomes:

Students who have done this course will have a good idea of the basics of IC engines and how different parameters influence the operational characteristics of IC Engines

Laboratory:

1. To study the cross-sectional view of I.C. engine.
2. Determination of the calorific value of a given fuel and its flash & fire points.
3. To study the actual valve timing diagram of 4-stroke engine.
4. To prepare the heat balance sheet by conducting performance test on a single cylinder 4-stroke diesel engine.
5. To prepare the heat balance sheet by conducting performance test on a single cylinder 4-stroke petrol engine.
6. Performance evaluation of multi cylinder Diesel Engine.
7. Conduct the Morse test on a multi cylinder petrol engine and find out the friction power.

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103702	Human Values & Ethics [2]	3L:0T:0P	0 credits

Course Outcome:

At the end of this course, students will demonstrate the ability to

- Identify the core values that shape the ethical behavior of an engineer.
- To create awareness on professional ethics and Human Values.
- To appreciate the rights of others.

Module 1 : HUMAN VALUES

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Co-operation – Commitment – Empathy – Self-confidence – Character – Spirituality – The role of engineers in modern society – Social expectations.

Module II : ENGINEERING ETHICS

Sense of 'Engineering Ethics' – Variety of moral issued – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of Professional Roles & Professionalism – theories about right action – Self-interest – customs and religion – uses of ethical theories.

Module III : ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation – engineers as responsible experimenters – Research ethics – Codes of ethics – Industrial Standard – Balanced outlook on law – the challenger case study.

Module IV : SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and risk – assessment of safety and risk – Riysis – Risk benefit analysis and reducing risk – Govt. Regulator's approach to risks – the three mile island and Chernobyl case studies & Bhopal – Threat of Nuclear Power, depletion of ozone, greenery effects – Collegiality and loyalty – respect for authority – collective bargaining – Confidentiality – conflicts of interest – occupation crime – professional rights – employees' rights – Intellectual Property Rights (IPR) – discrimination.

Module V : GLOBAL ISSUES

Multinational corporations – Business ethics – Environmental ethics – computer ethics – Role in Technological Development – Weapons development – engineers as managers – consulting engineers – engineers as expert, witnesses and advisors – Honesty – Leadership – sample code of conduct ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE), India, etc.,

Text / References:

1. Mika Martin and Roland Scinger, 'Ethics in Engineeering', Pearson Education/Prentice Hall, New York 1996.
2. Govindarajan M., Natarajan S., Senthil Kumar V. S., 'Engineering Ethics' Prentice Hall of India, New Delhi, 2004.
3. Charles D. Fleddermann, 'Ethics in Engineering', Pearson Education/Prentice Hall, New Jersey, 2004 (Indian Reprint).
4. Charles E. Harris, Michael S. Protchard and Michael J. Rabins, 'Engineering Ethics – Concept and Cases', Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available).
5. 'Concepts and Cases', Thompson Learning (2000).
6. John R. Boatright, 'Ethics and Conduct of Business', Pearson Education, New Delhi, 2003.
7. Edmund G. Seebauer and Robert L. Barry, 'Fundamentals of Ethics for Scientists and Engineers', Oxford University of Press, Oxford, 2001.

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| 107401 | **Business Analytics** | **3L: 0T: 0P** | **3 Credits** |

Contents

1 Unit 1: (8 Lectures) Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business An- alytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

8

2 Unit 2: (8 Lectures) Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

8

3 Unit 3: (8 Lectures) Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predictive Modelling Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

8

4 Unit 4: (10 Lectures) Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Fore- casting Time Series with Seasonality, Regression Forecasting with Casual Vari- ables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New- Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

10

5 Unit 5: (8 Lectures) Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent trends: In Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism. 8

Sl. No. Name of Authors / Books /Publishers

1. Business analytics Principles, Concepts, and Applications by Marc J.

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Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education

107704	**Wireless Communication**	3L: 0T: 0P 3 Credits

Contents

1   Introduction to Wireless Communication Systems: Evolution of mobile radio communications; examples of wireless comm. systems; paging systems; Cordless telephone systems; overview of generations of cellular systems, comparison of various wireless systems.   4

2   Introduction to Personal Communication Services (PCS): PCS architecture, Mobility management, Networks signalling. The Cellular Concept and Multiple Access Techniques: A basic cellular system, Frequency Reuse basic theory of hexagonal cell layout, spectrum efficiency, FDM/TDM, Cellular System, channel allocation schemes, Handover Analysis, cellular CDMA, Soft capacity, Erlang capacity comparison, multiple access techniques: FDMA, TDMA, CDMA.   9

3   2G Networks: Second generation, digital, wireless systems: GSM, I S136   (D-AMPS), IS-95 CDMA. Global system for Mobile Communication (GSM) system overview: GSM Architecture, Mobility Management, Network signalling, mobile management, voice signal processing and coding. Spread Spectrum Systems- Cellular code Division Access Systems-Principle, Power Control, effects of multipath propagation on code division multiple access.   11

4   2.5G Mobile Data Networks: Introduction to Mobile Data Networks, General Packet Radio Services (GPRS): GPRS architecture, GPRS Network nodes, EDGE, Wireless LANs, (IEEE 802.11), Mobile IP. Third Generation (3G) Mo- bile Services: Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G, Introduction to 4G.
11

5   Introduction to Wireless Channels and Diversity: Fast Fading Wireless Channel Modelling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Introduction to Diversity modelling for Wireless Communications.   5

Sl. No. Name of Authors / Books /Publishers

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice" 2nd Edition (2008), 2008

2. Andrew J Viterbi, "CDMA Principles of spread spectrum communications",Addition Wesley, 1995
3. J S Lee and L E Miller, "CDMA systems engineering handbook", Artech House,1998
4. Marvin K Simon, Jim K Omura, Robert A Scholtz, Bary Klevit, "Spread Spectrum Communications", 1995
5. Sergio Verdu, "Multiuser Detection", Cambridge University Press, 1998
6. Andrew S Tanenbaum, "Computer Network", Pearson/ PHI, 4th edition, 2009

107701	Chemical Reaction Engineering	3L: 0T:0P	3.0 Credits

Module 1   (10hours)
Rate of Reaction, Elementary and non-elementary homogeneous reactions, Molecularity and order of reaction, Mechanism of reaction, temperature dependency from thermodynamics, collision and activated complex theories. Integral and differential methods for analyzing kinetic data, interpretation of constant volume reactor, zero, first, second and third order reactions, half life period, irreversible reaction in parallel and series, catalytic reaction, auto catalytic reaction, reversible reactions.

Module 2   (8hours)
Interpretation of variable volume batch reactions for zero, first and second order reactions, Space-time and state-velocity, design equation for ideal batch, steady-state continuous stirred tank, steady-state plug flow reactors for isothermal reaction.

Module 3   (10hours)
Design for single reactions, Size comparison of single reactors, Multiple reactor systems, plug flow/mixed flow reactors in series and parallel, reactors of different types in series, optimum reactor size, recycle reactor, autocatalytic reactions.

Module 4   (10hours)
Introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size, selectivity, the side entry reactor, irreversible first-order reactions in series, Quantitative treatment: plug flow or batch reactor, Quantitative treatment: mixed flow reactor, Successive irreversible reactions of different orders, reversible reactions, irreversible series-parallel reactions.

Module 5   (8hours)
Residence time distribution of fluids in vessels, State of aggregation of the flowing systems,Earliness of mixing, Role of RTD, Conversion in Non-ideal flow reactors.

Text /References
Levenspiel, O., "Chemical Reaction Engineering", 3rd edition, John Wiley (1998).

107703	**Leather Product Technology-II**	**3L: 0T:3P**	**4.5 Credits**

Module 1.   Clicking   05
Characteristics and variations in leather, Material selection, Clicking of upper linings, Socks and fabrics.

Module 2.   Preparation (Pre – Closing)
      (a) Identification making, stitch making, Punching, Perforating and embossing.
      (b) Skiving – Objectives, different types skiving.
      (c) Reinforcements.
      (d) Topline and edge treatments.

            06
Module 3.   Closing operations
      (a) Stitching – Types of stitching m/c, Types of stitch, Different types of seam.
      (b) Eyeleting , lasting, etc

            05
Module 4.   Construction
Assembly, Definition of construction, Types of Construction, Flowchart of different construction, Details of cemented construction – Methods,
Details of moulded construction – DVP construction, Direct PVC moulded construction, Direct PU moulded construction, Veldtschoen construction, Machine welted construction. Slip – lasted construction, string lasted shoes.

            16
Module 5.   Treeing Department (Shoe-room operations)
Shoe-room operations for grain, leather and suede leather uppers.

            03
Module 6.   Quality control in footwear industry, Marketing of footwear, Hand tools and fittings for footwear industry.05
Suggested Books:
    1. Manual of Shoe – making – Clark.
    2. Text book of Footwear Manufacture – J. H. Thronton.
    3. Principle of Footwear Manufacture – Dr. Somnath Ganguly.

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107702	Theory of Leather supplements & Synthetics	3L: 0T:0P	3.0 Credits

Module 1 Chemistry of the most common Polymeric materials used in leather industry as supplements.

04

Module 2 Concept of a macromolecule, natural & synthetics polymer, modes of polymerization, radical, condensation, stereo regular polymerization, polymerization kinetics, mechanism, anionic and cationic polymerization.

10

Module 3 Manufacture of industrially important polymer for plastics, fibres and elastomer, polyethylene, polypropylene, polyvinyl, chloride, polyvinyl, alcohol, polyacrylonitrile, polyurethane, fluoro – carbon polymer, epoxy resins, polyamides, polyesters, alkyd resin, silicon polymers, cellulosics, polyacrylates, polyurethanes and their common applications.

12

Module 4 Testing of Polymers, Mechanical and thermal testing.

04

Module 5 Polymer and Rubber industries in India.

04

Module 6 Manufacture of Rubber and Synthetic rubber, Natural rubber processing and vulcanizing synthetic elastomers, butadiene copolymer, Polyisoprene, Polybutadiene, Thermosetting, Thermoplastic.

10

Text/References:
1. Introduction to the Principles of Leather Manufacture. By – S. S. Dutta, 4th Edition, ILTA, Kolkata
2. Theory & Practice of Leather Manufacture. By – K. T. Sarkar, Macmillan India Press, Chennai.

100708	**Biology for Engineers**	**2L:1T:0P**	**3 Credits**

Module 1: Introduction   **Lecture: 2 hrs.**

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry.

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2: Classification   **Lecture: 3 hrs.**

Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.

Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilisation -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (f) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus.

Module 3: Genetics   **Lecture: 4 hrs.**

Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"

Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4: Biomolecules   **Lecture: 4 hrs.**

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine.

Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5: Enzymes   **Lecture: 4 hrs.**

Purpose: To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6: Information Transfer   **Lecture: 4 hrs.**

Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Module 7: Macromolecular analysis   **Lecture: 5 hrs.**

Purpose: How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8: Metabolism   **Lecture: 4 hrs.**

Purpose: The fundamental principles of energy transactions are the same in physical and biological world.

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keqand its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

Module 9: Microbiology   **Lecture: 3 hrs.**

Purpose: Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Suggested Reference Books:
1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes

After studying the course, the student will be able to:
1. Describe how biological observations of 18th Century that lead to major discoveries.
2. Convey that classification per seis not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
3. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
4. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
5. Classify enzymes and distinguish between different mechanisms of enzyme action.
6. Identify DNA as a genetic material in the molecular basis of information transfer.
7. Analyse biological processes at the reductionistic level
8. Apply thermodynamic principles to biological systems.
9. Identify and classify microorganisms.

100701   Induction Program

Induction program (mandatory)	3 weeks duration
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch &Innovations

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आर्यभट्ट ज्ञान विश्वविद्यालय
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Civil Engineering

Pavement Design. Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behaviour under transient traffic loads. Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC Prerequisite:

Building Construction Practice. Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry – Bond in masonry - concrete hollow block masonry – flooring – damp proof courses – construction joints – movement and expansion joints – pre cast pavements – Building foundations – basements – temporary shed – centering and shuttering – slip forms – scaffoldings – de-shuttering forms – Fabrication and erection of steel trusses – frames – braced domes – laying brick –– weather and water proof – roof finishes – acoustic and fire protection; Sub Structure Construction- Techniques of Box jacking – Pipe Jacking - under water construction of diaphragm walls and basement-Tunnelling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points -Dewatering and stand by Plant equipment for underground open excavation; Super Structure Construction- Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavy decks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors Erection of articulated structures, braced domes and space decks; Prerequisite:

Transport of water and wastewater. The objective of the course is to make students gain insight into how the water and wastewater gets transported through conduits and open channels, and use the same for the design, operation and maintenance of these systems. Water Supply Systems: Storage

requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distribution systems, distribution and balancing reservoirs, pipe materials, appurtenances, design for external loads, maintenance and operation. <u>Sanitary</u> <u>Sewerage Systems</u>: Flow estimation, sewer materials, hydraulics of flow in sewers, sewer lay out, sewer transitions, materials for sewers, appurtenances, manholes, sewer design, conventional and model based design, sewage pumps and pumping stations, corrosion prevention, operation and maintenance, safety. <u>Storm water Drainage Systems:</u> Drainage layouts, storm runoff estimation, hydraulics of flow in storm water drains, materials, cross sections, design of storm water drainage systems, inlets, storm water pumping, operation and maintenance

Pipeline Engineering: The course should cover key issues for designing and operating pipelines for transmission and distribution of water; Analysis of flow in water transmission and water distribution systems (pump & gravity); optimal design and operation of systems for achieving different goals (including latest tools available for optimization); Extended period simulations, Software for WDN analysis and design, Rehabilitation of pipeline systems; Water auditing, online monitoring and control, leak and burst detection; transient analysis and surge protection; Appurtenances (valves / flow meters etc.); Selection of pipe material; Jointing details; Pipe laying and testing; Structural design for buried and surface mounted pipes

Pre-Requisite: Basic course in Hydraulic Engineering

Surface Hydrology. Study of descriptive and quantitative hydrology dealing with the distribution, circulation, and storage of water on the earth's surface; discusses principles of hydrologic processes and presents methods of analysis and their applications to engineering and environmental problems.

Prerequisite:

Masonry Structures. Introduction to analysis, design and construction of masonry structures. Mechanical properties of clay and concrete masonry units, mortar, and grout. Compressive, tensile, flexural, and shear behavior of masonry structural components. Strength and behavior of unreinforced bearing walls. Detailed design of reinforced masonry beams, columns, structural walls with and without openings, and complete lateral-force resisting building systems.

Prerequisite:

Wood Structures. Mechanical properties of wood, stress grades and working stresses; effects of strength- reducing characteristics, moisture content, and duration of loading and causes of wood

deterioration; glued- laminated timber and plywood; behavior and design of connections, beams, and beam-columns; design of buildings and bridges; other structural applications: trusses, rigid frames, arches, and pole-type buildings; and prismatic plates and hyperbolic paraboloids.

Prerequisite:

Concrete Technology. Concrete; Properties of ingredients, tests, Production of concrete, mixing, compaction curing, Properties of fresh concrete; Defects in Concrete, Concrete additives.; Behavior of concrete in tension and compression, shear and bond, Influence of various factors on test results, Time dependent behavior of concrete -creep, shrinkage and fatigue; Concrete mix design; Proportioning of concrete mixes, basic considerations, cost specifications, factors in the choice of mix proportion, different method of mix design. Quality control, Behavior of concrete in extreme environment; temperature problem in concreting, hot weather, cold weather and under water conditions, Resistance to freezing, sulphate and acid attack, efflorescence, fire resistance; Inspection and testing of concrete- Concrete cracking, types of cracks, causes and remedies Non-destructive tests on concrete; Chemical tests on cement and aggregates; Special concrete; types and specifications, Fibre reinforced and steel Fibre reinforced concrete, Polymer concrete, Use of admixtures; Deterioration of concrete and its prevention Repair and rehabilitation. Prerequisite:

Advanced Structural Analysis. Elasticity: Introduction, Components of strain and strain, Hooke's law, Plane stress and plane strain, Equations of equilibrium and compatibility, Boundary conditions, Two dimensional problems in rectangular and polar coordinates, Bending of simple and cantilever beams; Model Analysis: Structural similitude, Direct and indirect model analysis, Model material and model making, Measurement for forces and deformations; Introduction to Finite element method for structural analysis; Review of principle of virtual work, Ritz method, Discretization of domain, Basic element shape, Discretization process; Application of finite element method to one and two-dimensional plane stress strain elements.

Soil Mechanics-II. Application of soil mechanics to determine earth pressures, analysis of retaining walls, cuts & excavations and sheet piles, stability of slopes, instrumentation. Prerequisite:

Reference books:

- Soil Mechanics by Craig R.F., Chapman & Hall
- Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
- On successful completion of this course, the students:
- Should be able design retaining wall subjected to various loads with the knowledge of earth pressure theories.
- Should be able to design sheet pile wall with different methods.

- Should get familiarized with different construction practices for excavation with advantages and disadvantages of each method.
- Should be able to determine the safety analysis for slopes with different methods proposed in the syllabus. ☐ Should get introduced with the commercial softwares for analyzing the stability of slopes and retaining walls.

Environmental impact assessment and life cycle analyses. Evolution of EIA: Concepts of EIA methodologies, Screening and scoping; Rapid EIA and Comprehensive EIA; General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis, Definition of Risk, Matrix Method. Checklist method, Fault tree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities; Environmental Legislation; Introduction to Environmental Management Systems; Environmental Statement - procedures; Environmental Audit: Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control; Case Studies on EIA.

Groundwater Engineering: The main objective is to provide sufficient knowledge to the students about the groundwater hydrology, well hydraulics and well construction, geophysical explorations, groundwater quality and management of groundwater resources; Problems and perspectives regarding groundwater in India; Hydrogeology: Darcy's Equation; flow characteristics; general flow equations; unsaturated flow; Well Hydraulics: Steady and unsteady radial flows in aquifers; partially penetrating wells; multiple well systems; characteristic well losses; specific capacity, Surface and Subsurface investigations (Geologic methods; remote sensing; geophysical explorations; electrical resistivity and seismic refraction), Water Wells: Construction; completion, development, protection and rehabilitation of wells; Groundwater quality; Groundwater Management: Basin management, investigations, conjunctive use, modeling, artificial recharge; Saline water intrusion

Structural Dynamics. Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multidegree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; and introduction to systems with distributed mass and flexibility. Prerequisite:

Geographic Information Systems and Science. Investigation of geographic information systems (GIS) and science (GIScience) including theory and applications areas. A major portion of the course will be based on use of a current widely-used GIS computer software system. Aspects of geographic data entry and editing, spatial analysis, and map development and display will be considered. Relationship of GIS to the Global Positioning System (GPS) and satellite generated data will be addressed.

Prerequisite:

Civil Engineering Design-II. Innovation and creativity in conceptual design; sustainability; health and safety; investigative procedures. The use of analysis, synthesis and optimization in design; project planning, networks and graphs. Design of embankments, dams; drainage design; route location and alignment design of roads; assessment of natural hazard impacts and environmental impacts.

Prerequisite:

Public Transportation Systems: Public Transport: Definitions, modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements; Transit Network Planning: Planning Objectives, principles, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations; Transit Scheduling: Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling;Transit Agency and Economics: Organizational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure; Design of Facilities: Design of bus stops, design of terminals – principles of good layout, types of layout, depot location, twin depot concept, crew facilities and amenities.

Prerequisite:

Traffic Engineering and Management: Traffic Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection; Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Determination of design hourly volume; critical hour concept;Highway Capacity: Factors affecting capacity, level of service; Capacity studies - Capacity of different highway facilities including unsignalised and signalised intersections. Problems in Mixed Traffic flow; Case studies; Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions; Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications; Probabilistic Aspects Of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications; Simulation: Fundamental principle, application of simulation techniques in traffic

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engineering - formulation of simulation models, Case studies. Formulation of system models.
Prerequisite:

Foundation Engineering. Analysis and design of foundations, types of foundations, bearing capacity and settlement of foundations; ground movements due to construction; analysis and design of excavations, retaining walls, cuts & excavations and sheet piles, slopes and underground structures.

Prerequisite:

Reference books:

- A. Singh, Modern Geotechnical Engineering, 3rd Ed., CBS Publishers, New Delhi, 1999. B.M. Das, Principles of Foundation Engineering, 5th Ed., Thomson Asia, Singapore, 2003. N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.
- After successful completion of this course, the students would:
- Learn about types and purposes of different foundation systems and structures.
- Have an exposure to the systematic methods for designing foundations.
- Be able evaluate the feasibility of foundation solutions to different types of soil conditions considering the time effect on soil behaviour.
- Have necessary theoretical background for design and construction of foundation systems.

Structural Analysis by Matrix Methods. Analysis of truss and frame structures using flexibility and stiffness methods of matrix analysis; computer applications. Prerequisite:

Structural Mechanics. Beams under lateral load and thrust; beams on elastic foundations; virtual work and energy principles; principles of solid mechanics, stress and strain in three dimensions; static stability   theory; torsion; computational methods. Prerequisite:

Reinforced Concrete. Study of the strength, behavior, and design of reinforced concrete members subjected to moments, shear, and axial forces; extensive discussion of the influence of the material properties on behavior.

Prerequisite:

Structural Analysis-II. Analysis of building frames; Kani's, moment distribution and other methods and Approximate methods; Stiffness matrix method; Application to simple problems of beams and frames; Flexibility matrix method; Application to simple problems of beams and frames; Moving loads for determinate beams; Different load cases, Influence lines for forces for determinate beams; Influence lines for pin-jointed trusses; Influence lines for indeterminate beams using Muller Breslau principle. Influence lines for Arches and stiffening girders.

Prerequisite:

Decision and Risk Analysis. Development of modern statistical decision theory and risk analysis, and application of these concepts in civil engineering design and decision making; Bayesian statistical decision theory, decision tree, utility concepts, and multi-objective decision problems; modeling and analysis of uncertainties, practical risk evaluation, and formulation of risk-based design criteria, risk benefit trade-offs, and optimal decisions. Prerequisite:

Design of Concrete Structures-I. Study of the strength, behavior, and design of indeterminate reinforced concrete structures, Load and stresses, load combinations, Working stress and limit state approach. Analysis and design of sections in bending – working stress and limit state method, Rectangular and T-sections, Beams with reinforcement in compression, One-way slab. Design for shear and bond, Mechanism of shear and bond failure, Design of shear using limit state concept, Development length of bars; Design of sections in torsion. Design of two-way slabs; Design of flat slab – direct method; Circular slab; Slab type staircase, Placement of reinforcement in slabs; Voided slab. Design of compression members, Short column, Columns with uniaxial and bi-axial bending; Long columns, use of design charts. Design of foundation; Wall footing, Isolated and combined footing for columns. All designs to be as per the most recent BIS standards as applicable Prerequisite:

Environmental Fluid Mechanics. Incompressible fluid mechanics with particular emphasis on topics in analysis and applications in civil engineering areas; primary topics include principles of continuity, momentum and energy, kinematics of flow and stream functions, potential flow, laminar motion, turbulence, and boundary-layer theory. Prerequisite:

Unsteady Open Channel Flow: This course should discuss how to analyze for unsteady flows in open channels; Derivation of 1-D and 2-D shallow water flow equations; Consideration for non-hydrostatic pressure distribution; Basics of numerical methods: FiniteDifference and Finite Element Methods; Latest shock capturing Finite Volume methods for solving 1-D and 2-D shallow water flow equations; Dambreak flow; Flood routing in large channel networks, Flood routing in compound channels; Flood routing in channels with flood plains, Surface irrigation flow modeling

Pre-Requisite: Basic course in Hydraulic Engineering

Environmental Laws and Policy. Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law, Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc., Introduction to trade and environment. International environmental laws, Right to Environment as Human Right, International Humanitarian

Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.

Rock Mechanics. Determination of physical properties of rocks, failure criterion, rock mass classification, stress around mine openings, strain and displacement of the rock mass, rock reinforcement and support, subsidence.

Prerequisite:

Reference books:

- Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson and
- J. P. Harrison
- Rock Mechanics: For Underground Mining by Barry H.G. Brady □ Fundamentals of Rock Mechanics, 4th Edition, John Conrad Jaeger, Neville G. W. Cook, Robert Zimmerman

- On successful completion of this course the students will be able to:
- Define the properties (viz., physical, mechanical) of rocks and failure criterion of rock mass.
- Use engineering rock mass classification (RMR, Q-system, RQD)
- Analyse the stress distribution insitu and around an opening in underground structures (viz., mine openings, tunnels).
- Determine the relation between strain and displacement components of rockmass.
- Perform field Instrumentation techniques and laboratory studies. □ Understand the fundamentals of ground subsidence.

Earthquake Engineering. Theory of Vibrations; Concept of inertia and damping - Types of Damping - Difference between static forces and dynamic excitation - Degrees of freedom - SDOF idealization - Equations of motion of SDOF system for mass as well as base excitation - Free vibration of SDOF system - Response to harmonic excitation - Impulse and response to unit impulse - Duhamel integral; Multiple Degree of Freedom System; Two degree of freedom system - Normal modes of vibration - Natural frequencies - Mode shapes - Introduction to MDOF systems - Decoupling of equations of motion - Concept of mode superposition (No derivations); Elements of Seismology; Causes of Earthquake - Geological faults - Tectonic plate theory - Elastic rebound – Epicentre; Hypocentre - Primary, shear and Raleigh waves - Seismogram - Magnitude and intensity of earthquakes - Magnitude and Intensity scales - Spectral Acceleration - Information on some disastrous earthquakes; Response of Structures to Earthquake; Response and design spectra - Design earthquake - concept of peak acceleration - Site specific response spectrum - Effect of soil properties and damping - Liquefaction of soils - Importance of ductility - Methods of introducing ductility into RC structures Design Methodology IS 1893, IS 13920 and IS 4326 - Codal provisions - Design as per

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the codes - Base isolation techniques - Vibration control measures - Important points in mitigating effects of earthquake on structures Prerequisite:

Transients in Closed Conduits: This course should cover key issues for understanding the unsteady flow in pipes (water hammer) and designing for surge protection**;** Differential equations for unsteady pipe flow; Characteristic method for solution; Formulation of boundary conditions; transients in pumping mains (power failure; pump start up); transients in penstocks of hydro-electric schemes; analysis for transient control using surge tanks; air chambers; air valves; pressure regulating valves etc.; Emphasis should be on development of computer programs for transient analysis; awareness about commercially available software for transient analysis

Pre-Requisite: Basic course in Hydraulic Engineering

Urban Hydrology and Hydraulics. Hydraulic analysis and design of urban, highway, airport, and small rural watershed drainage problems; discussion of overland and drainage channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; runoff for highways, airports, and urban areas; design of drainage gutters, channels, sewer networks, and culverts.

Prerequisite:

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Mechanical Engineering

102702	Refrigeration and Air Conditioning	3L:0T:3P	4.5 credits

Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning
2. To understand basic refrigeration processes
3. To understand the basics of psychometric and practice of applied psychometrics
4. To acquire the skills required to model, analyses and design different refrigeration as well as air conditioning processes and components.

Course Content:

Module: 1

Air refrigeration system: Refrigeration machine, heat pump, coefficient of performance, ideal refrigeration cycle, Bell – Coleman, refrigeration cycle, open and closed systems, application of air-refrigeration in air-crafts.   **(Lectures 6)**

Module:2

 Various compression systems: Simple vapour compression refrigeration cycle, merits and Refrigerants demerits of this system over air refrigeration system, factors affecting the performance of a vapour compression refrigeration system, sub cooling and superheating of vapour, wet and dry compression, multistage vapour compression system, intercooler, flash chamber, accumulator and heat exchanger.   **(Lectures 8)**

Module: 3

 Vapour absorption system: Simple and modified vapour absorption refrigeration system, Electrolux refrigerator, COP of heat operated refrigeration system.   **(Lectures 5)**

Module: 4

 Special refrigeration system, absorption, cascade, vortex, thermoelectric and steam jet refrigeration system.   **(Lectures 4)**

Module: 5

Refrigerants: classification and nomenclature of refrigerants, primary and secondary refrigerants, properties of some common refrigerants, physical, chemical and thermodynamics properties, selection of refrigerants, leakage of refrigerants and methods of detection.

(Lectures 3)

Module:6

Psychometry: Properties of air vapour mixture, wet bulb, dew point & dry bulb temperatures, humidity, specific humidity, humidity ratio, degree of saturation, relative humidity, total heat psychometric relation, psychometric charts and its uses, psychometric processes evaporative cooling.

(Lectures 5)

Module: 7

Air conditioning: General principle and requirement for comfort and air conditioning, thermodynamics of human body, estimation of heating and cooling loads, capacity of cooling coils, humidification and dehumidification unit and conditioner, central air conditioner, year around air condition, humidity and temperature control, industrial application of air conditioning system

(Lectures 10)

Module: 8

Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils. **(Lectures 4)**

Course Outcomes:

A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

Note: Refrigeration Data Books are permitted for examination.

Text Books:

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition,Prentice Hall, 1998.

Practical:

1. Determination of the COP of a vapour compression system.
2. Determination of the COP of vapour absorption apparatus.
3. Determination of the COP of a heat pump.
4. To find the performance parameter of cooling tower.
5. To study various components of room air conditioner and determine its performance for different psychometric condition.
6. Determination of COP of an Electrolux refrigerator.
7. To study the compressor and throttling valve used in refrigerator.

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102703	Computer Aided Design	3L:0T:3P	4.5 credits

Objectives:

To provide an overview of how computers can be utilized in mechanical component design

Contents:

Module: 1

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation.   **(Lectures 10)**

Module: 2

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep.

(Lectures 10)

Module: 3

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation.   **(Lectures 8)**

Module: 4

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards.   **(Lectures 12)**

Course Outcomes:

Upon completion of this course, the students can use computer and CAD software for modelling mechanical components

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co.2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education,1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Grahics, McGraw Hill,1989.
4. D. Hearn and M.P. Baker, Computer Graphics, Prentice Hall Inc.,1992.

Practical:

1. Initiating the Graphics Package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.
2. Drawing of primitives (Line, arc, circle, ellipse, triangle etc.)
3. Drawing a flange.
4. Drawing a bushing assembly.
5. Dimensioning the drawing and adding text.
6. Setting the layers and application of layers.
7. Isometric and Orthographic projections.
8. Viewing in three dimensions.

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9. Removal of hidden lines – Shading and Rendering.

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102704	**Finite Element Analysis**	3L:0T:3P	4.5 credits

Objectives:

1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

Contents:

Module: 1

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.   **(Lectures 8)**

Module: 2

One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and naturalfrequencies.

(Lectures 12)

Module: 3

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

(Lectures

12)

Module: 4

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software.   **(Lectures 8)**

Course Outcomes:

Upon completion of the course, students will understand the FEM formulation and its application to simple structural and thermal problems

Text Books:

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill,2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi,2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rded., Butterworth Heinemann, 2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

Practical:

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Use these software for experiments: ANSYS, SIMULIA, ABAQUS, MATLAB etc.

1. Force and stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi-symmetric components.
5. Thermal stress and heat transfer analysis of plate.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of beams.

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102705	Automobile Engineering	3L:0T:3P	4.5 credits

Objectives:

To understand the construction and working principle of various parts of an automobile

Contents:

Module: 1

Types of automobiles, vehicle construction and layouts, Car body Style, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT), Front engine front wheel drive, Front engine Rear wheel drive, foure wheel drive.

(Lectures 6)

Module: 2

Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).   **(Lectures 6)**

Module: 3

Transmission systems, clutch types, cone clutch, Single plate, multi plate, diaphragm spring & centrifugal clutch, electromagnetic clutch & construction, gear boxes- manual and automatic gear shift mechanisms, over drive principles, transfer box, Transaxles, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive**.**   **(Lectures 8)**

Module:4

Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, constructional details & characteristics of Leaf spring, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.   **(Lectures 8)**

Module: 5

Caster, Camber, King pin inclination Toe in Toe out, Full Floating, three quarter floating &semi Floating rear axles.   **(Lectures 5)**

Module: 6

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells.

(Lectures 7)

Course Outcomes:

Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:

1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
3. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
4. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

Practical:

1. To study and prepare report on the constructional details, working principles and operation of the Automotive Clutches.

2. To study and prepare report on the constructional details, working principles and operation of the Automotive Transmission systems.

3. To study and prepare report on the constructional details, working principles and operation of the Automotive Drive Lines & Differentials.

4. To study and prepare report on the constructional details, working principles and operation of the Multi-cylinder: Diesel and Petrol Engines.

5. To study and prepare report on the constructional details, working principles and operation of the Fuels supply systems.

6. To study and prepare report on the constructional details, working principles and operation of the Engine cooling & lubricating Systems.

7. To study and prepare report on the constructional details, working principles and operation of the Automotive Suspension Systems.

8. To study and prepare report on the constructional details, working principles and operation of the Automotive Steering Systems.

9. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems.

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Electrical Engineering

103703	**Digital Signal Processing**	**3L:0T:0P**	**3 credits**

Course Outcomes:
At the end of this course, students will demonstrate the ability to
- Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- Analyse discrete-time systems using Z-transform.
- Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- Design digital filters for various applications.
- Apply digital signal processing for the analysis of real-life signals.

Module 1: Discrete-time signals and systems (6 hours)
Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals aliasing; Sampling theorem and Nyquistrate.

Module 2: Z-transform (6 hours)
z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z- transforms.

Module 2: Discrete Fourier Transform (10 hours)
Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Module 3: Design of Digital filters (12 hours)
Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters.
Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.
Module 4: Applications of Digital Signal Processing (6 hours)
Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:
1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

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| 103704 | Electromagnetic waves | 3L:0T:0P | 3 credits |

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.
- Provide solution to real life plane wave problems for various boundary conditions.
- Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
- Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
- Understand and analyse radiation by antennas.

Module 1: Transmission Lines (6 hours)

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations (6 hours)

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

Module 3: Uniform Plane Wave (7 hours)

Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module 4: Plane Waves at Media Interface (7 hours)

Planewaveinarbitrarydirection,Planewaveatdielectricinterface,Reflectionandrefractionofwaves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 5: Waveguides (7 hours)

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.

Module 6: Antennas (7 hours)

Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertzdipole, Near field, Far field, Total power radiatedyadipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

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Text/Reference Books

1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

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103705	Computational Electromagnetics	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the basic concepts of electromagnetics.
- Understand computational techniques for computing fields.
- Apply the techniques to simple real-life problems.

Module 1: Introduction **(6 hours)**

Conventional design methodology, Computer aided design aspects – Advantages. Review of basic fundamentals of Electrostatics and Electromagnetics. Development of Helmhotz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transients and time-harmonic.

Module 2: Analytical Methods **(6 hours)**

Analytical methods of solving field equations, method of separation of variables, Roth's method, integral methods- Green's function, method of images.

Module 3: Finite Difference Method (FDM) **(7 hours)**

Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.

Module 4: Finite Element Method (FEM) **(7 hours)**

Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

Module 5: Special Topics **(7 hours)**

{Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (graphical method)}, hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations, method of moments, Poisson's fields.

Module 6: Applications **(7 hours)**

Low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators. CAD packages.

Text/Reference Books

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press,1996.
2. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press,2001.

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Electronics & Communication Engineering

104704 Antennas and Wave Propagation   3L:0T:0P   3 Credits

Contents

Fundamental Concepts : Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Radiation: Potential function and electromagnetic fields, a small current element radiation, Power radiated by current element and radiation resistance, Radiation from quarter wave monopole and half wave dipole.

Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non- uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkun off polynomial method, Woodward-Lawson method.

Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic re- flector and cassegrain antennas.

Broadband Antennas: Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.

Microstrip Antennas: Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Basic Concepts of Smart Antennas: Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming. Different modes of Radio Wave propagation used in current practice.

Guided waves and waveguides: Waves between parallel planes. TM and TE waves, Their propagation and attenuation in parallel plane guides, Rectangular wave guides – TE and TM waves in rectangular guides, Wave impedance, Circular wave guides, Introduction to resonators.

Sl. No. Name of Authors / Books /Publishers

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1 "Antennas", J.D. Kraus, McGraw Hill, 1988
2 "Antenna Theory - Analysis and Design", C.A. Balanis, John Wiley, 1982
3 "Antenna Engineering Handbook", McGraw hill, 1984
4 "Micro Strip Antennas", I.J. Bahl and P. Bhartia, Artech House, 1980
5 "Electromagnetic Waves", R.K. Shevgaonkar, Tata McGraw Hill, 2005
6   "Electromagnetic Waves and Radiating Systems", (Prentice-Hall Electrical Engineering Series)
   by Edward C. Jordan, 2006
7 "Antennas and Radio Wave Propagation", R.E. Collin, McGraw Hill, 1985

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104705   **Optical Fiber Communication   3L:0T:0P   3 Credits**

1. Introduction: Optical Fiber :-Structures, Wave guiding and Fabrication Nature of light, Basic optical laws and Definition, Optical fiber modes and Con- figuration, Mode theory for circular waveguides, Single mode fibers, Graded index fiber, Fiber materials, Fabrication and mechanical properties, Fiber optic cables, Basic Optical Communication System, Advantage of Optical Communication System

2. Attenuation in Optical Fibers: Introduction, Absorption, Scattering, Very Low Loss Materials, All Plastic and Polymer-Clad-Silica Fibers. Wave Prop- agation: Wave propagation in Step-Index and Graded Index Fiber, Overall Fiber Dispersion-Single Mode Fibers, Multimode Fibers, Dispersion-Shifted Fiber, Dispersion, Flattened Fiber, Polarization

3. Source and Detectors: Design and LED's for Optical Communication, Semiconductor Lasers for Optical Fiber Communication System and their types, Semiconductor Photodiode Detectors, Avalanche Photodiode Detector and Photo multiplier Tubes. Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling. Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors. Optical receiver operation-Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of error, Quantum limit, Analog receivers

4. **Optical Fiber Communication Systems:** Data Communication Networks – Network Topologies, Mac Protocols, Analog System. Advanced Multiplexing Strategies – Optical TDM, Sub carrier Multiplexing, WDM Network. Archi- tectures: SONET/SDH. Optical Transport Network, Optical Access Network, Optical Premise Network. Applications-Military Applications, Civil, Consumer and Industrial Applications.

Sl. No.   Name of Authors / Books /Publishers

1. "Optical Communication System", Gowar, IEEE Press – 2nd Edition
2. "Fiber Optics and Opto Electronics", R.P.Khare, Oxford Publication
3. "Optical Information Processing", F. T. S. Yu, Wiley, Newyork, 1983
4. "Fiber optic Communication Systems", John Wiley and sons, New York, 1992
5. "An Introduction to Fiber Optics", A. Ghatak, K. Thyagarajan, Cambridge University Press.
6. "Optical Communication Components and Systems", J. H. Franz and V. K. Jain, Narosa Publish, 2013.

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7. "Optical Fiber Communications", John M. Senior, PEARSON, 3rd Edition,2010

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104706 Micro and Nano Electronics   3L: 0T: 0P   3 Credits

Contents

1. EVOLUTION OF NANOELECTRONICS Moore's Law, Silicon Electronics, Limitations, Discussion of the International Technology Roadmap char- acteristics: Need for new concepts in electronics, Silicon MOS Transistor from Micro to Nano, Future Opportunities, Nanocomputing

2. TUNNEL JUNCTIONS AND APPLICATIONS OF TUNNELING Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces – Metal -Insulator, Metal - Semiconductor, and Metal – Insulator- Metal Junctions , Applications of Tunneling, Field Emission, Gate - Oxide Tunneling and Hot Electron Effects in MOSFETs, Double Barrier Tunneling and the Resonant Tunneling Diode.

3. BALLISTIC AND SPIN TRANSPORT Coulomb Blockade , Tunnel Junction Excited by a Current Source , Coulomb Blockade in a Quantum Dot Circuit , Single Electron Transistor, Ballistic Transport , Electron Col- lisions and Length Scales, Ballistic Transport Model, Quantum Resistance and Conductance, Transport of Spin and Spintronics Devices ,Applications.

4. MOLECULAR ELECTRONICS Introduction to molecular electronics - An atomistic view of electrical resistance, Schrodinger equation, Self - consis- tent field, Bandstructure, Level broadening, Coherent transport, Non-coherent transport in molecular electronics devices , Molecular Devices, Logic Switches, Interface Engineering - Issues

Sl. No.   Name of Authors / Books /Publishers

1	George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007
2	K a r l Goser et.al, "Nanoelectronics and Nanosystems: From Transistors toMolecular and Quantum devices", Springer, 2005
3	Mark. A. Reed and Takhee, "Molecular Electronics", American Scientific Publishers, 2003
4	Mitin V., V. Kochelap, and M. Stroscio, "Introduction to", Cambridge University Press, 2008
5	Michael C. Petty, "Molecular Electronics: From Principles to Practice", JohnWiley and Sons, Ltd, 2007.
6	Ramachandran K. I. et.al, "Computational Chemistry and Molecular Modeling", Springer, 2008.
7	J. H. Franz and V. K. Jain, "Optical Communication Components and Systems", Narosa Publish, 2013
8	John M. Senior, "Optical Fiber Communications", PEARSON, 3rd Edition, 2010.

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104707   Embedded System 3L:0T:0P   3 Credits

Contact

1.   Introduction to Embedded Systems: Definition of Embedded System. Embedded Systems Vs General Computing Systems.   History of Embedded Systems. Classification, Major Application Areas. Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.   Typical Embedded System: Core of the Embedded System: General Purpose and Do- main Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Compo- nents (COTS), Memory: ROM. RAM. Memory according to the type of Inter- face. Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators. Communication Interface: On board and External Communication Interfaces, Programming.

2.   Embedded Firmware: Reset Circuit. Brown-out Protection Circuit. Oscillator Unit. Real lime Clock. Watchdog Timer, Embedded firmware Design Approaches and Development Languages. RTOS Based Embedded System De- sign: Operating System Basics, Types of Operating Systems, Tasks. Process and Threads. Multiprocessing and Multitasking, Task Scheduling.

3.   Task Communication: Shared Memory. Message Passing. Remote Procedure Call and Sockets. Task Synchronization: Task Communication/Synchronization Issues. Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

4.   Introduction to ARM: ARM Architecture ARM Design Philosophy, Registers, Program Status Register. Instruction Pipeline Interrupts and Vector Table. Architecture Revision, ARM Processor Families.

5.   ARM Programming: Instruction Set: Data Processing Instructions. Addressing Modes. Branch. Load. Store Instructions, PSR Instructions. Conditional Instructions. Thumb Instruction Set: Register Usage, Other Branch Instructions. Data Processing Instructions. Single-Register and Multi Register Load-Store Instructions. Stack. Software Interrupt Instructions.

6.   ARM Programming in C: Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation. Conditional Execution and Loops

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1   Embedded System Design -Frank Vahid, Tony Givargis, John Wiley.
2   C -Michael J. Pont, 2nd Ed., Pearson Education, 2008.
3   ARM Systems Developer's Guides-Designing and Optimizing System Software Andrew N. Sloss. Dominic Symes. Chris Wright, 2008. Elsevier.
4   Introduction to Embedded Systems -Shibu K.V, Mc Graw Hill.

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104708   High Speed Electronics   3L:0T:0P   3 Credits

Contents

1.   Transmission line theory : Basics, Crosstalk and non-ideal effects, Signal integrity, Impact of packages, Vias, Traces, Connectors, Non-ideal return cur- rent paths, High frequency power delivery, Methodologies for design of high speed buses, Radiated emissions and minimizing system noise, Noise Analysis, Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range

2.   Devices: Passive and active, Lumped passive devices (models), Active (models, low vs. high frequency).

3.   RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages.

4.   Mixers, Up conversion Down conversion, Conversion gain and spurious response, Oscillators Principles, PLL Transceiver architectures.

5   Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards, Board Assembly, Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.

Sl. No. Name of Authors / Books /Publishers

1. "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", Stephen H. Hall, Garrett W. Hall, James A. McCall, Wiley- IEEE Press,2000
2. "The Design of CMOS Radio-Frequency Integrated Circuits", Thomas H. Lee, Cambridge University Press, 2004
3. "RF Microelectronics", Behzad Razavi, Prentice-Hall, 1998
4. "Microwave Transistor Amplifiers", Guillermo Gonzalez, 2nd Edition, Prentice Hall
5. "RF and Microwave Wireless systems", Kai Chang, Wiley
6. "Electronic Product design", R.G. Kaduskar and V.B.Baru, Wiley India, 2011

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104709   Digital System Design   3L:0T:1P   4 Credits

Contents

1.   Introduction to Digital Design Concepts: Review of digital design fundamentals, minimization and design of combinational circuits, sequential machine fundamentals

2.   Clocked Sequential Finite State Machines: State diagram, analysis of synchronous circuits, derivation of state graphs and tables, reduction of state tables, state assignment, design of sequence detectors, serial data code conversion, design of synchronous sequential state machine, design and applications of counters and shift registers

3.   Multiinput System Controllers Design: System controller, controller design principles, timing and frequency considerations, DFD development, controller architecture design, asynchronous input handling, state assignment concepts, flip-flop level implementation using VEM's

4.   Sequential Design using LSI & MSI circuits: Using decoders, multiplexers in sequential circuits, sequential network design using ROMs, PLAs and PALs, Programmable gate Arrays (PGAs)

5   Asynchronous Sequential Finite State Machines: Introduction, analysis of asynchronous networks, races and cycles, derivation of primitive flow tables, reduction of primitive flow tables, state assignments, hazards,   asynchronous sequential network design

6   VHDL: Why VHDL? Basic Language Elements, Data objects, classes and data types, operators, overloading, logical operators, VHDL representation of Digital design entity and architectural declarations, introduction to behavioral, dataflow and structural models

Sl. No. Name of Authors / Books /Publishers

1   William I Fletcher "An Engineering Approach to Digital Design", PHI, 3rd Indian reprint, (1994)
2   Z Navabi "VHDL-Analysis and Modelling of Digital Systems", McGraw Hill, 2nd Edition (1997)
3   Kevin Skahill "VHDL for Programmable Logic", Pearson Education, 1st Indian Reprint (2004)
4   Jr. Charles H. Roth, "Fundamentals of Logic Design", Jaico Publishers, 4th Edition, (2002).
5   M Morris Mano "Digital Design", Pearson Education, 3rd Edition (2002)

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104710   VLSI Technology 3L:0T:0P   3 Credits

Contents

1   Introduction to MOS technology: Introduction to IC technology, MOS and related VLSI technology, Basic MOS transistors (Enhancement mode and depletion mode), NMOS process, CMOS process (P – Well, N – Well, Twin – tub processes), Bi CMOS process flow, aspects of CMOS and Bi CMOS devices.

2   Brief introduction of VLSI: Architecture Definition, Functional Design, Logic Design, Circuit Design and Physical Design

2   Crystal growth and doping: Starting materials, Czochralski technique, Gradient freeze technique, Considerations for proper crystal growth (role of point defects, thermal gradients, turbulences, pull and spin rate, crystal orientation, crystal hardening techniques), Doping (rapid stirring conditions, partial stirring conditions,   radial doping variations), Zone processes (Zone refining, Zone leveling, neutron transmutation doping)

3   Diffusion: Diffusion in a concentration gradient, Diffusion equation, Impurity behavior in Silicon, diffusion systems for Silicon, redistribution during oxide growth, diffusion during oxide growth, cooperative diffusion, evaluation techniques for diffused layers in Silicon.

4   Epitaxy: Nucleation and growth, doping, dislocation, thermally induced strain, Molecular Beam exitaxy, Vapor phase epitaxy for Silicon, Liquid phase epitaxy.

5   Ion-Implantation: Penetration range (nuclear and electronic stopping, Transverse effects), Implantation damage, annealing, Ion – Implantation systems, process consideration, high energy and high current implants.

6   Native Films : Thermal Oxidation of silicon (kinetics of oxide growth, oxidation systems, oxidation induced stacking faults, properties of thermal oxides), Thermal nitridation of Silicon, Plasma.

7   Deposited Films: Films deposition methods (vacuum evaporation, sputter deposition, Chemical vapor Deposition), Film characteristics (step coverage, grown habit, mechanical stress, electromigration)

8   Etching and Cleaning : wet chemical etching in silicon based processes, Dry physical etching, Dry chemical etching, Reactive Ion etching, Etch induced damage, Cleaning (wet and dry).

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9   Lithography :   Photo reactive materials, pattern generation and mask making, pattern transfer- optical printing, advanced techniques (short wavelength, multilayer resist, phase shifting masks, Electron beam techniques, Xray printing), Mask defects, Pattern transfer defects.

10   Process integration: Isolation, (P-N junction, Mesa, Oxide), self alignment, local oxidation, planarization, metallization, gettering, Process flow for CMOS

Sl. No.   Name of Authors / Books /Publishers

1   'Basic VLSI Design by Pucknell and Eshraghian.
2   VLSI Fabrication Principles by Sorab Gandhi.
3   The science and engineering of Microelectronic Fabrication by Stephen Campbell.
4   VLSI Design by Sujata Pandey and Manoj Pandey.
5   CMOS VLSI design by Wolfe.

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104711   Information and Coding Theory   3L:0T:0P   3 Credits

Contents

1   Information Theory: Definition of Information, Entropy, Mutual Information, Properties of Mutual Information, Fundamental Inequality, I.T. Inequality, Divergence, Properties of Divergence, Divergence Inequality, Relationship between entropy and mutual information, Chain Rules for entropy, relative entropy and mutual information.

2   Channel Capacity: Uniform Dispersive Channel, Uniform Focusing Channel, Strongly Symmetric Channel, Binary Symmetric Channel, Binary Erasure Channel. Channel Capacity of the all these channels, Channel Coding Theo- rem, Shannon-Hartley Theorem.

3   Data Compression: Kraft inequality, Huffman codes, Shannon-Fano coding, Arithmetic Coding.

4   Linear Block Codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the MacWilliams identities; Perfect codes. Cyclic Codes, BCH codes; Reed- Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes.

5   Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift-register synthesis technique and its relation to Berlekamp's algo- rithm. A fast Berlekamp - Massey algorithm.

6   Convolution codes: Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm, Turbo Codes, Concatenated Code

Sl. No.   Name of Authors / Books /Publishers

1   Simon Haykin, "Communication Systems", 4th Edition, John Wiley and Sons, 2001
2   ArijitSaha, "Information Theory, Coding and Cryptography", Pearson Education, 2013
3   Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory", Wiley India Pvt. Ltd, 2nd Edition, 2013

4 J.Mary Jones, "Information and Coding Theory", Springer, 2000
5 Ranjan Bose, "Information Theory, Coding and Cryptography", Tata Mc-Graw Hill, 2nd Edition, 2008

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Computer Science Engineering

105701	Data Science	3L:0T:0P	3 Credits

Objectives of the course

The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Detailed Contents

Module 1   **Lecture 4 hrs.**

1. Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping,

Analysis vs Reporting

Module 2   **Lecture 6 hrs.**

2. **Introduction to Programming Tools for Data Science**

    2.1   Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK

    2.2   Visualizing Data: Bar Charts, Line Charts, Scatterplots

    2.3   Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Module 3   **Lecture 12 hrs.**

3. **Mathematical Foundations**

    3.1   Linear Algebra: Vectors, Matrices,

    3.2   Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation

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3.3   Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem

3.4   Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference

Module 4   **Lecture 16 hrs.**

4. Machine Learning

Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine Learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- Model Assumptions, Regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning And Generalization, Overview of Deep Learning.

Module 5   **Lecture 6 hrs.**

5. Case Studies of Data Science Application

Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

6. List of Practicals

1. Write a programme in Python to predict the class of the flower based on available attributes.
2. Write a programme in Python to predict if a loan will get approved or not.
3. Write a programme in Python to predict the traffic on a new mode of transport.
4. Write a programme in Python to predict the class of user.
5. Write a programme in Python to indentify the tweets which are hate tweets and which are not.
6. Write a programme in Python to predict the age of the actors.
7. Mini project to predict the time taken to solve a problem given the current status of the

user.

Reference Books:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Presshttp://www.deeplearningbook.org
8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

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105702	Computational Complexity	3L:0T:0P	3 Credits

Detailed Contents

Module 1   **Lecture 8 hrs.**

Models of Computation, resources (time and space), algorithms, computability, complexity.

Module 2   **Lecture 8 hrs.**

Complexity classes, P/NP/PSPACE, reductions, hardness, completeness, hierarchy, relationships between complexity classes.

Module 3   **Lecture 8 hrs.**

Randomized computation and complexity; Logical characterizations, incompleteness; Approximability.

Module 4   **Lecture 8 hrs.**

Circuit complexity, lower bounds; Parallel computation and complexity; Counting problems; Interactive proofs.

Module 5   **Lecture 8 hrs.**

Probabilistically checkable proofs; Communication complexity; Quantum computation.

Reference Books:

1. Christos H. Papadimitriou., Combinatorial Optimization: Algorithms and Complexity, Prentice-Hall.
2. Sanjeev Arora and Boaz Barak, Complexity Theory: A Modern Approach, Cambridge University Press
3. Steven Homer, Alan L. Selman, Computability and Complexity Theory, Springer

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105703	Advanced Computer Architecture	3L:0T:0P	3 Credits

Detailed contents

Module 1   **Lectures: 8 hrs**.

Classes of computers, Trends in technology, power and costs, dependability, quantitative principles of computer design, Introduction to computing models.

Module 2   **Lectures: 10 hrs**.

Principles of scalable performance, performance metrics and measures, speedup performance laws, advanced processor technology, super scalar and VLIW processors, Verified memory, cache memory organizations, shared memory organizations. Memory hierarchy, cache performance, protection and examples of virtual memory, cache coherence.

Module 3   **Lectures: 8 hrs**.

Pipeline and superscalar techniques, linear pipeline processors, reservation and latency analysis, collision free scheduling, pipeline schedule optimization, instruction pipeline design, arithmetic pipeline design, super scalar and super pipeline design.

Module 4   **Lectures: 7 hrs**.

Multiprocessors and multi-computers, Brief overview of SIMD, MIMD, vector architectures and multi-core architectures.

Module 5   **Lectures: 7 hrs**.

Elementary theory about dependence analysis, techniques for extraction of parallelism, branch prediction, dynamic scheduling, multiple issue and speculation, limits on instruction level parallelism, Thread level parallelism

Reference Books:

1. Computer Architecture: A Quantitative Approach : Hennessy and Patterson : Morgan Kaufmann
2. Advanced Computer Architecture, Kai Hwang , McGraw Hill
3. Advanced Computer Architectures: A design space approach, Sima D, Fountain T. and

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Kacsuk P, Pearson Education

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105704	Theory of Computation	3L:0T:0P	3 Credits

Detailed contents

Logic: First-order predicate calculus - syntax, semantics, validity and satisfiability, decision problems in logic, quantified Boolean formulas and their relation with the polynomial hierarchy.

Computability theory: Review of Turing machines, some other computing models and formalisms, their equivalence with Turing machines, undecidability, Post correspondence problem, Turing computability, primitive recursive functions, Cantor and Goedel numbering, Ackermann function, mu-recursive functions, recursiveness of Ackermann and Turing computable functions, lambda calculus, term rewriting, oracle machines and the arithmetic hierarchy.

Complexity theory: Time- and space-bounded Turing machines, reduction and complete problems, oracle machines and the polynomial hierarchy, randomized computation, parallel computation.

Reference Books:

1. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.

2. Fred C. Hennie. Introduction to Computability. Addison-Wesley.

3. Bernard M. Moret, The Theory of Computation, Pearson Education Asia.

4. Christos H. Papadimitriou, Computational Complexity, Addison-Wesley Longman.

5. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.

6. John Martin, Introduction to Languages and The Theory of Computation, Tata McGraw Hill.

7. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

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105705	Internet of Things	3L:0T:0P	3 Credits

Objectives of the Course:

The objective of this course is to impart necessary and practical knowledge of components of

Internet of Things and develop skills required to build real-life IoT based projects.

Detailed contents

Module 1   **Lectures 8 hrs.**

Introduction to IoT: Architectural Overview, Design principles and 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.

Module 2   **Lectures 9 hrs.**

Elements of IoT: Hardware Components – Computing (Arduino, Raspberry 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.

Module 3   **Lectures 18 hrs.**

IoT Application Development: 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.

Module 4   **Lectures 10 hrs.**

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.

List of Suggested Books:

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling

Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

Learning Outcomes:

After the completion of this course, the students will be able to:

1. Understand internet of Things and its hardware and software components
2. Interface I/O devices, sensors & communication modules
3. Remotely monitor data and control devices
4. Develop real life IoT based projects

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105706	Natural Language Processing	3L:0T:0P	3 Credits

Detailed contents

Module 1   **Lecture 6 hrs.**

Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Module 2   **Lecture 6 hrs.**

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Module 3   **Lecture 8 hrs.**

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

Module 4   **Lecture 6 hrs.**

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Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Coreferences.

Module 5   **Lecture 8 hrs.**

Web 2.0 Applications: Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

Reference Books:

1. Jurafsky, Dan and Martin, James, "Speech and Language Processing", 2nd Edition, Prentice Hall, 2008
2. Manning, Christopher and Heinrich, Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999
3. Allen James, "Natural Language Understanding", 2nd edition, Benjamin Cumming, 1995
4. Charniack, Eugene, "Statistical Language Learning", MIT Press, 1993

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105707	E-Commerce and ERP	3L:0T:0P	3 Credits

Module 1   **Lecture: 10 hrs.**

Introduction to E- Commerce: Evolution of E-commerce, Advantage and Disadvantage of E Commerce, Roadmap of E-Commerce in India. Business Models of E–Commerce: Model Based On Transaction Party: B2B, B2C, C2B, C2C.

Module 2   **Lecture: 10 hrs.**

E marketing: The scope of E-Marketing, Identifying Web Presence goals, Uniqueness of the web, Meeting the need of website visitors, Website Design Issues: Factors that make People Return to Your Site, Strategies for Website Development. Site Adhesion: Content, format and access: maintaining a Website, E- Advertising, E-Branding,

Module 3   **Lecture: 10 hrs.**

E–Payment System: Digital Payment Requirement, Digital Token based E-Payment System, Electronic Cash, Smart card and Electronics payment system: Credit and Debit Card, Virtual Currency, Digital wallet, Risk of Electronics payment system, Digital Signature.

E Security: Security On the Internet: Network and Website Security Risk: Denial-of-Service attack, Viruses, Unauthorized access to computer Network. Security Standards: Firewall, Cryptography, Key Management, Password Systems, Digital certificates, Digital signatures.

Module 4   **Lecture: 10 hrs.**

Enterprise Resource Planning (ERP): Introductory Concepts, Advantages & disadvantages of ERP, ERP and Related Technologies: - Business Process Reengineering, Data Warehousing, Data Mining, Supply Chain Management. **ERP Implementation:** ERP Implementation Life Cycle –Implementation Methodology, Hidden Costs , Organizing Implementation – Contracts with Vendors, Consultants and Users , Project Management and Monitoring.

Module 5   **Lecture: 7 hrs.**

ERP Business Modules: Introduction to basic Modules of ERP System, Business Modules in an ERP Package- Finance – Manufacturing – Human Resource – Plant Maintenance – Materials Management – Quality Management – Sales and Distribution.

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Case Study: Recent business issues on E-Commerce Perspective**.**

Text Books:

1. Alexis Leon, "ERP Demystified", Tata McGraw Hill.
2. E-Commerce An Indian Perspective by P.T.Joseph, PHI

Reference Books

1. K.K. Bajaj, D. Nag "E-Commerce", 2nd Edition, McGraw-Hill Education, New Delhi.
2. Bhaskar Bharat, "Electronic Commerce-Technology and Application", McGraw-Hill Education, New Delhi.
3. Mary Sumner, "Enterprise Resource Planning", 2005, PHI Learning India Pvt. Ltd. /Pearson Education, New Delhi.
4. Chan, "E-Commerce fundamentals and Applications", Wiley India, New Delhi.
5. Vinod Kumar Garg and N.K .Venkata Krishnan, "Enterprise Resource Planning – concepts and Planning", Prentice Hall, 1998.

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105708	**Robotics and Robot Application**	**3L:0T:0P**	**3 Credits**

Objective of the Course:

The objective of this course is to impart knowledge about industrial robots for their control and design.

Detailed contents

Module 1   **Lectures 3 hrs.**

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

Module 2   **Lectures 7 hrs.**

Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics. Dynamic Modelling: Equations of motion: Euler-Lagrange formulation.

Module 3   **Lectures 10 hrs.**

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc., Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean / Similarity / Affine / Projective transformations. Vision applications in robotics.

Module 4   **Lectures 12 hrs.**

Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID. Non-linear and advanced controls.

Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Module 5   **Lectures 10 hrs.**

Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications.

List of Suggested Books:

1. Saha, S. K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi, 2009
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley and Sons Inc, 2005
8. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003
9. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, "Intelligent Mechatronic System: Modeling, Control and Diagnosis", Springer.

Learning Outcomes:

After the completion of this course, the students will be able to:

1. Perform kinematic and dynamic analyses with simulation.
2. Design control laws for a robot.
3. Integrate mechanical and electrical hardware for a real prototype of robotic device.
4. Select a robotic system for given application.

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Information Technology

106703 - Real Time Systems

Module I

Introduction to real time computing - Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems

Module II

Real time OS – Threads and Tasks – Structure of Microkernel – Time services – Scheduling Mechanisms Communication and Synchronization – Event Notification and Software interrupt

Module III

Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms- Fault tolerant scheduling

Module IV

Real Time Communication -Network topologies and architecture issues – protocols – contention based, token based, polled bus, deadline based protocol, Fault tolerant routing. RTP and RTCP.

Module V

Real time Databases – Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability.

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Text Book

1. C.M. Krishna, Kang G. Shin – " Real Time Systems", International Edition, McGraw Hill Companies, Inc., New York, 1997

Reference Books

1. Jane W.S. Liu, Real-Time Systems, Pearson Education India, 2000.

2. Philip A. Laplante and Seppo J. Ovaska, "Real-Time Systems Design and Analysis: Tools for the Practitioner'' IV Edition IEEE Press, Wiley. 2011

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106704 - Mobile and Wireless Computing

Module I

Introduction to Wireless Networks: Applications, History, Simplified Reference Model, Wireless transmission, Frequencies, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular Systems.

Module II

MAC: Motivation, SDMA, FDMA, TDMA, CDMA, Telecommunication Systems: GSM, DECT, TETRA. UMTS, MT-2000.

Module III

Wireless LAN, Infrared Vs Radio transmission, Infrastructure, Adhoc Network, 802.11, HIPERLAN, Bluetooth, Mobile Network Layer, Mobile IP, Dynamic Host Configuration Protocol.

Module IV

Adhoc Networks, Mobile Transport Layer, Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Time-out freezing, Selective retransmission, Transaction Oriented TCP.

Module V

Support for Mobility, File Systems, WWW, Wireless Application Protocol.

Text Book

1. Jochen Schiller, "Mobile Communications", Pearson Education, Asia Publications, 2000.

Reference Book

1. William Stallings, "Wireless Communication and Networks", PHI/Pearson Education, 2002.
2. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", PHI/Pearson Education, 2003.
3. HazysztofWesolowshi, "Mobile Communication Systems", John Wiley and Sons Ltd, 2002.

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106710	Cryptography and Network Security	3L:0T:0P	3 Credits

Detailed contents

Module 1   **Lectures: 7 hrs**.

Security Services, Mechanisms and Attacks, TheOSI Security Architecture, A Model for Network Security. Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotol Machines, Steganography.

Module 2   **Lectures: 7 hrs**.

Simplified DES, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation.

Module 3   **Lectures: 7 hrs**.

Finite Fields and Confidentiality: Groups, Rings, and Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields of the Form GF (p), Polynomial arithmetic, Finite Fields of the Form GF(2"), Placement of Encryption Function, Traffic Confidentially, Key Distribution, Random Number Generation.

Module 4   **Lectures: 7 hrs**.

Encryption Standard and Ciphers: Evaluation criteria for AES, AES cipher, Multiple encryption and Triple DES, Block cipher Modes of operation, Stream ciphers and RCG.

Module 5   **Lectures: 7 hrs**.

Number Theory and Public-Key Cryptography: Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms, Principles of Public-Key Cryptosystems, The RSA Algorithm,

Module 6   **Lectures: 7 hrs**.

Message Authentication, Function, Algorithms and Digital System: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs, Secure Hash Algorithm, HMAC, Digital Signatures, Authentication Protocols.

Text Book:

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1. W.Stallings : Cryptography and Network Security : Principles and Practice, 4/e Pearson Education, New Delhi, 2006.

Reference Books:

1. B.A. Forouzan – Cryptography and Network Security, TMH, New Delhi, 2007
2. B. Schneier – Applied Cryptography, John Wiley, Indian Edition, 2006.

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110 - Electrical Electronics & Engineering

110701	Electromagnetic waves	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.
- Provide solution to real life plane wave problems for various boundary conditions.
- Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
- Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
- Understand and analyse radiation by antennas.

Module 1: Transmission Lines (6 hours)

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations (6 hours)

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss' slaw, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

Module 3: Uniform Plane Wave (7 hours)

Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module 4: Plane Waves at Media Interface (7 hours)

Planewaveinarbitrarydirection,Planewaveatdielectricinterface,Reflectionandrefractionofwaves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 5: Waveguides (7 hours)

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.

Module 6: Antennas (7 hours)

Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Text/Reference Books

1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

110703	High Voltage Engineering	3L:0T:0P	3 credits

Course outcomes:

At the end of the course, the student will demonstrate
- Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
- Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
- Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
- Knowledge of how over-voltages arise in a power system, and protection against these over voltages.

Module 1: Breakdown in Gases (8 Hours)
Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge

Module 2: Breakdown in liquid and solid Insulating materials (7 Hours)
Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Module 3: Generation of High Voltages (7 Hours)
Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Module 4: Measurements of High Voltages and Currents (7 Hours)
Peak voltage, impulse voltage and high direct current measurement method, cathode erayoscillo

graphs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module 5: Lightning and Switching Over-Voltages   (7 Hours)

Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Module 6: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 Hours)

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and

bushings,testingofisolatorsandcircuitbreakers,testingofcables,powertransformersandsomehigh voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Text/Reference Books

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals",Newnes Publication,2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley& Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

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110704	Industrial Electrical Systems	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to
- Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
- Understand various components of industrial electrical systems.
- Analyze and select the proper size of various electrical system components.

Module 1: Electrical System Components   (8 Hours)

LTsystemwiringcomponents,selectionofcables,wires,switches,distributionbox,meteringsystem, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Module 2: Residential and Commercial Electrical Systems   (8 Hours)

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: Illumination Systems   (6 Hours)

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of alighting scheme for a residential and commercial premises, flood lighting.

Module 4: Industrial Electrical Systems I   (8 Hours)

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Module 5: Industrial Electrical Systems II   (6 Hours)

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Module 6: Industrial Electrical System Automation (6 Hours)

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books
1. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

| 110707 | Digital Control Systems | 3L:0T:0P | 3 credits |

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(State University, Estd. By Bihar Act 24, 2008)

Course Outcomes:

At the end of this course, students will demonstrate the ability to
- Obtain discrete representation of LTI systems.
- Analyse stability of open loop and closed loop discrete-time systems.
- Design and analyse digital controllers.
- Design state feedback and output feedback controllers.

Module 1: Discrete Representation of Continuous Systems (6 hours)
Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Module 2: Discrete System Analysis (6 hours)
Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

Module 3: Stability of Discrete Time System (4 hours)
StabilityanalysisbyJurytest.Stabilityanalysisusingbilineartransformation.Designofdigitalcontrol system with dead beat response. Practical issues with dead beat response design.

Module 4: State Space Approach for discrete time systems (10 hours)
State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module 5: Design of Digital Control System (8 hours)
Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Module 6: Discrete output feedback control (8 hours)
Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books:
1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

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Course Outcomes:

At the end of this course, students will demonstrate the ability to
- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

Module 1: Introduction (10 hours)

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive- train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module 3: Electric Trains (10 hours)

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module 4: Energy Storage (10 hours)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications,

supporting subsystems

Module 5: Energy Management Strategies (9 hours)

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and FuelCell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.