Dr. Babasaheb Ambedkar Technological University, Lonere.

Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

Telephone and Fax. : 02140 -275142

COURSE STRUCTURE AND SYLLABUS

For

Final Year B. Tech. Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering

With effect from the Academic Year 2020-2021(Final Year)

Dr. Babasaheb Ambedkar Technological University, Lonere.

B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

Curriculum for Semester VII [Final Year]

Sr. No.	Course Code	Type of Course	Course Title	Hours per week			Evaluation Scheme			Total Marks	Credits
				L	T	P	MSE	CA	ESE		
1	BTEEC701	PCC1	Power System Operation & Control	3	0	0	20	20	60	100	3
2	BTEEC702	PCC2	High Voltage Engineering	3	0	0	20	20	60	100	3
3	BTEEC703	PCC3	Electrical Drives	3	0	0	20	20	60	100	3
4	BTEEE704	PEC1	Elective-IX	3	0	0	20	20	60	100	3
5	BTEEE705	PEC2	Elective-X	3	0	0	20	20	60	100	3
6	BTEEL706	Lab	Power System Operation & Control Lab	0	0	2	--	30	20	50	1
7	BTEEL707	Lab	High Voltage Engineering Lab	0	0	2	--	30	20	50	1
8	BTEEL708	Lab	Electrical Drives Lab	0	0	2	--	30	20	50	1
9	BTEES709	Seminar	Seminar	0	0	2	--	30	20	50	1
10	BTEEP710	Project	Project Part-I	0	0	6	--	30	20	50	3
11	BTEEF711	--	Field Training /Internship/Industrial Training III	--	--	--	--	--	50	50	1
			Total	**15**	**0**	**14**	**100**	**250**	**450**	**800**	**23**

Elective-IX	Elective-X
A) Special Purpose Electrical Machines	A) Digital Signal Processing
B) Electrical Traction and Utilization	B) Energy Audit and Conservation
C) Engineering System Design and Optimization	C) Electrical Power Quality
D) Financial Management	D) HVDC Transmission and FACTS

Dr. Babasaheb Ambedkar Technological University, Lonere.

B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

Curriculum for Semester VIII [Final Year]

Sr. No.	Course Code	Course Title	Hours per week			Evaluation Scheme			Total Marks	Credits
			L	T	P	MSE	CA	ESE		
		1.Power Management Integrated Circuits 2.DC Power Transmission Systems 3.High Power Multilevel Converters 4.Fuzzy Sets, Logic and Systems & Applications 5.The Joy of Computing using Python 6.Introduction to Industry 4.0 and Industrial Internet of Things 7.Entrepreneurship Essentials **# Student to opt any two subjects from above list**	3	0	0	20*	20*	60*	100	3
			3	0	0	20*	20*	60*	100	3
6	BTEEP803	Project - II	0	0	30	--	100	150	250	15
		Total	**6**	**0**	**30**	**40**	**240**	**270**	**450**	**21**

Six months of Internship in the industry

Students doing project at institute will have to appear for CA/MSE/ESE

* Student doing project at Industry will give NPTEL examination / Examination conducted byuniversity i.e. CA/MSE/ESE*

These subjects are to be studied on self –study mode using SWAYAM/NPTEL/Any other source

Teacher who work as a facilitator for the course should be allotted 3 hrs/week load.

Project Load: 2hrs/week/project.

Mapping of Courses with MOOCs Platform SWYAM / NPTEL

S.N.	Course Name	Duration	Name of Professor	Institute offering Course
1	Power Management Integrated Circuits	12 Weeks	Prof. Qadeer Ahmad Khan	IITM
2	DC Power Transmission Systems	12 Weeks	Prof. Krishna S	IITM
3	High Power Multilevel Converters	12 Weeks	Prof. Anandarup Das	IITD
4	Fuzzy Sets, Logic and Systems & Applications	12 Weeks	Prof. Nishchal Kumar Verma	IITK
5	The Joy of Computing using Python	12 Weeks	Prof. Sudarshan Iyengar Prof. Yayati Gupta	IIT Ropar
6	Introduction to Industry 4.0 and Industrial Internet of Things	12 Weeks	Prof. Sudip Misra	IIT KGP
7	Entrepreneurship Essentials	12 Weeks	Prof. Manoj Kumar Mondal	IIT KGP

BTEEC701: POWER SYSTEM OPERATION AND CONTROL	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial: 0	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Prerequisite:

1. Power System-II

Course Objectives:

1. To understand the fundamental concepts of power system.
2. To obtain mathematical model of Synchronous machine, excitation and speed governing system.
3. To analyze the transient stability of power system.
4. To understand the economic operation of power system.
5. To explain various techniques of reactive power and voltage Control

Course Outcome:

1. Explain the fundamental concept of power system.
2. Design the mathematical model of synchronous machine.
3. Design the mathematical model Excitation system and speed governing system.
4. Analyze the transient stability of power system using swing equation and equal area criteria.
5. Analyze the economic operation of power system.
6. Explain the methods of Voltage control.

UNIT I. FUNDAMENTALS OF POWER SYSTEM: **(6hr)**

Concepts of real and reactive powers, complex power, per-unit representation of power system, Transmission capacity, load characteristics, real power balance and its effect on system frequency, load frequency mechanism, reactive power, balance and its effect, on-load tap changing transformer and regulating transformer

UNIT II. SYNCHRONOUS MACHINE MODELLING **(8hr)**

Schematic diagram, Physical description: armature and field structure, machines with multiple pole pairs, MMF waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation

UNIT III. MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEM **(8hr)**

Elements of an Excitation System; Types of Excitation System; Control and protective functions; Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine, special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modelling: Single reheat tandem compounded type and cross compound type.

UNIT IV. TRANSIENT STABILITY: (6hr)

Solution of Swing equation using classical model, application of equal area creation on point by point solution

UNIT V. ECONOMIC OPERATION OF POWER SYSTEM: (6hr)

Distribution of load between units within a plant, transmission loss as function of plant generation, calculation of loss-coefficient, distribution of loads between plants with special reference to steam and hydro plants, automatic load dispatching, Unit commitment, constraints on unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming.

UNIT VI. REACTIVE POWER AND VOLTAGE CONTROL: (6hr)

Production and absorption of reactive power- Methods of Voltage Control – Shunt reactors – Shunt Capacitors – Series Capacitors – Synchronous condensers – Static Var systems – Principles of Transmission system compensation – Modeling of reactive compensating devices

Reference Books:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. Gross C. A., 'Power System Analysis' McGraw Hill
3. Arrilaga J., 'Computerised Power system Analysis' McGraw Hill
4. Foud Anderson, 'Power system control dynamics' McGraw Hill
5. Kaushik, 'Computerised Power system Analysis' McGraw Hill
6. Padiyar K. R., 'Power system dynamics, ' New Age International

BTEEC702: HIGH VOLTAGE ENGINEERING	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial: 0	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Pre-requisite: Electrical Engineering Materials,Power systems I, Power Systems II

Course Objectives:
1. To study conduction and breakdown in gases, liquids and solids.
2. To understand the methods and measurement of high voltage generation and measurement
3. To explain the lightening phenomenon and insulation co-ordination.
4. To know different non-destructive testing and standards in HV.

Course Outcomes:

1. Illustrate the concept of electric field stresses, applications of insulating materials and methods for Non-destructive testing of equipment like transformers, insulators, isolators, bushings, lightning arrestors, cables, circuit breakers and surge diverters.
2. Explain the breakdown process in solid, liquid, and gaseous materials
3. Analyze methods for generation and measurement of High Voltages and Currents (both ac and dc)
4. Describe the phenomenon of over-voltage and choose appropriate insulation co-ordination levels based on IS & IEC Standards.

UNIT I: INTRODUCTION TO HIGH VOLTAGE ENGINEERING   (2hr)

Electric Field Stresses,Poisson's equation, Estimation and Control of Electric Stress, Surge Voltages, their distribution and control.

UNIT II:CONDUCTION & BREAKDOWN IN GASES: (6hr)

Gases as insulation media, ionization processes, Townsend's current growth equation, current growth in presence of secondary processes, Townsend's criterion for breakdown in electronegative gases, time lags for breakdown, Streamers theory, Paschen's law, breakdown in non-uniform fields and corona discharge, corona under positive & negative polarities, glow & arc discharge, considerations in using gases for insulation purpose.

UNIT III: BREAKDOWN IN DIELECTRIC MATERIALS: (8hr)

Conduction & breakdown in liquid dielectrics: Pure and commercial liquids, breakdown in pure and commercial liquids, theories of breakdown in liquids. Breakdown in solid dielectrics: Intrinsic, electromechanical& thermal breakdown, chemical, electrochemical deterioration, treeing, tracking, internal discharges, breakdown in composite insulation, properties of solid insulators & other materials used in practice. Insulating materials: In power transformers, rotating machines, circuit breakers, cables, power capacitors & other equipment.

UNIT IV: OVER VOLTAGE DUE TO LIGHTENING PHENOMENON: (8hr)

Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, propagation of lightning voltage & current waves on transmission lines, reflection & transmission of traveling wave at junction, system control of over voltage due to switching protection of transmission lines against over voltage. Insulation co-ordination, surge diverters, equipment insulation level & co-ordination of substations.

UNIT V:GENERATION & MEASUREMENT OF HIGH VOLTAGES & CURRENTS: (10hr)

Generation of a) high d. c voltage b) power frequency high alternating voltage c) high frequency a. c. d) impulse voltages Standard impulse waves shapes and it's equation, multistage impulse generator, matrix circuit, generation of switching surges, tripping & control of impulse generators, generation of impulse currents.
Measurement of High Direct Current voltages, Abraham Voltmeter Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements

UNIT VI:NON DESTRUCTIVE TESTING: (6hr)

I.E.C. & IS codes for high voltage tests on electrical appliances & power apparatus &electrical motors, non- destructive testing, testing of insulators, bushings, isolators, circuit breakers, cables, transformers, surge diverter, layout of high voltage laboratories & test facilities.

Reference Books:
1) High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition
2) High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.
3) High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, RoshdyRadwan, Marcel Dekker

Text Books:
1. Kamaraju V. & Naidu M. S., 'High Voltage Engineering', Tata-McGraw Hill
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Pvt. Ltd

BTEEC703: ELECTRICAL DRIVES	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial: 0	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Pre requisite   : Electrical machine-II, Power Electronics

Course objective :

Students will be able to understand the dynamics of drive system.
Students will be able to use various methods of speed control of AC and DC Drive.
Students will be have the ability to analyze the drive system
Students will be able to select proficiently and the proper drive system for particular application.
Students will be able to have basic knowledge of recent advancement in Electric Drive.

Course outcomes:

Analyze the dynamics of Electrical Drives system.
Use various control techniques for controlling the speed of AC and DC motors.
Analyze the AC and DC drives.
To Select/recommend the appropriate Drive according to the particular applications.
State the recent technology of AC and DC drive

UNIT I: . INTRODUCTION   (8hr)

Advantages of Electrical Drives, Parts of Electrical drive, Choice of Electric drives Dynamics of Electrical drives: fundamental torque equations, multiquadrant operation, nature and classification of load torques, steady state stability, concept of load equalization in drives

UNIT II. .CONTROL OF ELECTRICAL DRIVES   (6hr)

Modes of operation: Steady state, Acceleration, Deceleration, Drive classification. Closed loop control of drives : Current limit control, torque control, speed control, position control, Control of multi motor drives, speed sensing, current sensing, Classes of motor duty & criteria for selection of motor.

UNIT III. DC MOTOR DRIVES   (7hr)

Review of basic characteristics of DC motors, Single phase drives : Single phase half wave converter drives, semi converter drives, Full converter drives, Dual converter drives. Three phase drives : Three phase half wave drives, semi-converter drives, full converter drives, dual-converter drives,

DC-DC converter drives: Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives. Introduction to closed loop control of DC drives.

UNIT IV: INDUCTION MOTOR DRIVES (7hr)

Review of starting, braking and speed control of three phase induction motors, Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control, Current control, Closed loop control of Induction motors, Principle of Scalar and Vector control of Induction motor, Multiquadrant operation of induction motor drives fed from Voltage Source Inverters. Static rotor resistance control method, static slip power recovery control-Static Scherbius drive and StaticKramer drive.

UNIT V: SYNCHRONOUS MOTOR DRIVES (6hr)

Review of starting, pull in and braking of Synchronous motor,Static variable frequency control for Synchronous motors,Load commutated inverter fed Synchronous motor drive, Introduction to closed loop control of Load commutated inverter fed Synchronous motor drive.

UNIT VI: DRIVES FOR SPECIFIC APPLICATIONS (6hr)

Textile Mill: various stages and drive requirements control of ac motors for controlling torque. Steel Rolling Mill : reversing and continuous hot and cold rolling mills, Drive requirements, motors for mill drive. Cement mill : Stages in cement production, requirements of mill motors, Kiln drives, crusher drives, fan/blower drives, compressor drive. Sugar Mill : Requirements for various drive motors, selection of motors for various processes

Ref Books:
1. Dubey G. K., "Fundamentals of Electrical Drives", Narosa Publishing house
2. De N. K., Sen P. K., "Electric Drives", Prentice Hall of India
3. VedamSubramanyam, "Electrical Drives and Control", TMH Publications

BTEEE704A: SPECIAL PURPOSE ELECTRICAL MACHINES	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial: 0	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Prerequisite:

AC Machines and DC Machines

Course Objectives:

To impart knowledge on Construction, principle of operation and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, Permanent magnet brushless D.C. motors , Permanent magnet synchronous motors.

Course Outcome:

After Completion of this Course, student will be able

1. Demonstrate construction, working principle, and application of various types of special purpose electrical machines
2. Select a special Machine for a particular application
3. Demonstrate behaviour of induction generator and induction machine.

UNIT I. SYNCHRONOUS RELUCTANCE MOTORS   (6hr)

Constructional features , Types – Axial and radial air gap motors – Operating principle – Reluctance – Phasor diagram - Characteristics – Vernier motor.

UNIT II. STEPPING MOTORS   (6hr)

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Theory of torque predictions – Linear and non-linear analysis – Characteristics – Drive circuits.

UNIT III. SWITCHED RELUCTANCE MOTORS   (6hr)

Constructional features – Principle of operation – Torque prediction – Power controllers – Non-linear analysis – Microprocessor based control - Characteristics – Computer control.

UNIT IV. PERMANENT MAGNET BRUSHLESS D.C. MOTORS   (8hr)

Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control.

UNIT V. PERMANENT MAGNET SYNCHRONOUS MOTORS   (8hr)

Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers - Converter - Volt-ampere requirements – Torque speed characteristics - Microprocessor based control.

UNIT VI. INDUCTION MACHINES   (6hr)

Induction generator–self excitation requirement – voltage regulation – different methods of voltage control –doubly fed induction machine – generation operating mode– linear Induction Motor

Text Books:

1. K.Venkataratnam, Special Electrical Machines, Universities Press (India) Private Limited, 2008.
2. T. Kenjo, Stepping Motors and Their Microprocessor Controls, Clarendon Press London, 1984
3. E.G. Janardanan, Special electrical machines, PHI learning Private Limited, Delhi, 2014.

References:

1. R.Krishnan, Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application, CRC Press, New York, 2001.
2. T. Kenjo and S. Nagamori, Permanent Magnet and Brushless DC Motors, Clarendon Press, London, 1988.
3. T.J.E.Miller,Brushless Permanent-Magnet and Reluctance Motor Drives, Oxford University Press, 1989.
4. R.Srinivasan, Special Electrical Machines, Lakshmi Publications, 2013.

BTEEE704B: ELECTRIC TRACTION & UTILIZATION	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits:3	End Term Exam: 60 Marks

Prerequisite:

➢ Basics of Electrical Engineering and Electrical Machine-II.

Course Objectives:

1. To possess knowledge of advanced and emerging topics in traction mechanism and illumination engineering and their applications in the field.
2. An ability to design a traction system, a component, to meet desired needs of locomotive industry within realistic constraints and confirms manufacturability, and sustainability.
3. To mold students professionally to possess in-depth and advanced knowledge by course contents along with emerging topics.

Course Outcomes:

After Completion of this Course, student will be able to
1. Identify types of Traction System.
2. Interpret Various Power supply in Electric Traction.
3. Analyze Various Traction Motors.
4. Define methods of Traction motor Control.
5. Elobrate Train movement & Breaking in Traction system.
6. Classify the indoor and outdoor Illumination system.

UNIT I: ELECTRIC TRACTION SYSTEM: (8hr)
Electrical transmission: Electrical transmission system employing D.C. generator D.C. series motor, Electrical transmission system employing 3 phase alternator supplying D.C. traction motors, electrical transmission employing 3 phase alternator supplying induction motors, Choice of traction system-battery drive, hybrid drive, flywheel drive, tramways, trolley bus. Track electrification: D.C. System, single phase low frequency A.C. system, single phase high frequency A.C. system, 3 phase A.C. system and composite system.

UNIT II: POWER SUPPLY FOR ELECTRIC TRACTION: (6hr)
Current collection system, current collectors for Over Head Systems, Overhead construction for Tramways and trolley buses and railways, Sag and Tension calculation for a trolley wire, Traction substations, location of substations, feeding and distributing system, substation

equipment's. Block Diagram of AC Electric locomotive, Signaling interference in tele-communication circuits.

UNIT III: TRACTION MOTORS: (6hr)

Characteristics of traction motors, straight D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. Traction Motors, Series motor using undulating D.C, suitability of shunt motor for traction duty, single phase series motors, Repulsion motor, compensated repulsion motor, Induction motor with variable frequency with SCR, Linear Induction motor.

UNIT IV: TRACTION CONTROL: (6hr)

Traction control: Duty cycle, Methods of traction motor control, series-Parallel and other types of controllers, use of interlocks, run back prevented, multiple unit control, Master controllers, Reverses, Dead man's handle, use of Metaldyne and Megavolt.

UNIT V: TRAIN MOVEMENT AND BRAKING: (8hr)

Speed time curve, its analysis and construction, schedule speed and factors affecting it, train resistance and its components. Tractive effort calculations, average acceleration and speed, energy output and consumption.

Braking: Mechanical versus electric breaking, rheostatic braking, Regenerative braking, method and energy saved in the process, Magnetic track brakes.

UNIT VI: ILLUMINATION: (6hr)

Requirement of good lighting, Classification of light fitting & luminaries, factors to be considered for design of indoor & outdoor lighting scheme, Design Procedure for factory lighting, street lighting.

Reference Books:

1) Utilization of Electrical Power and Electic Traction by J.B. Gupta. (Katson Book publisher)
2) H. Partab: Modern Electric Traction, Dhanpat Rai & sons.
3) Upadhayay J. & Mahindra S.N., Electric Traction, Allied Publishers Ltd., 1st Ed.
4) Rao P.S., Principle of 25 KV Overhead Equipments. R. (Nasik) Printpack Pvt Ltd,, 1st Ed.
5) Electric Traction for Railway Trains, by Edward P. Burch. McGraw Hill Book Co. Inc.
6) C.L.Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Publishers.

BTEEE704C: ENGINEERING SYSTEM DESIGN OPTIMIZATION	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Pre requisite: Linear Algebra, Non-linear Problems

Course Outcome:

1. To understand different level optimization problem formulation.
2. To study novel methods in optimization.
3. To understand and develop genetic algorithm for engineering problems.

UNIT I: INTRODUCTION (8hr)

Introduction to Optimization problem formulation, optimization algorithms, applications and examples, different optimization methods available

UNIT II: SINGLE VARIABLE OPTIMIZATION (6hr)

Optimization criteria, bracketing methods– Exhaustive search method, bound phase method, Region Elimination methods– Fibonacci search method, Golden search method, Gradient based methods– Newton Raphson method, Bisection method, Root finding using optimization technique

UNIT III: MULTI OBJECTIVE OPTIMIZATION (6hr)

Optimization criteria, Different search methods, Unidirectional search, Direct search method – Evolutionary optimization method, Powell's conjugate direction method, Gradient based methods– Newton's method and Variable metric method.

UNIT IV: SPECIALIZED METHODS (6hr)

Integer programming, Geometric programming, simulated annealing, Global optimization using - steep descent method, simulated annealing.

UNIT V: GENETIC ALGORITHMS AND EVOLUTIONARY APPROACHES (6hr)

Differences and similarities between genetic algorithms and traditional techniques, operators of GA's, Computer program for simulated annealing, Newton Raphson method, Evolutionary optimization method.

References
1. Kalyanmoy Deb, "Optimization for Engineering design", Prentice Hall,India, 2005.
2. Kalyanmoy Deb, "Multi objective optimization using Evolutionaryalgorithms", John Wiley,2001

BTEEE704D: FINANCIAL MANAGEMENT	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits:3	End Term Exam: 60 Marks

Course Objectives:
• To help the students to develop cognizance of the importance of Financial Management in corporate valuation
• To enable students to describe how people analyze the corporate leverage under different conditions and understand why people valuate different corporates in different manner.
• To provide the students to analyze specific characteristics of Supply Chain Industry and their future action for cash flow
• To enable students to synthesize related information and evaluate options for most logical and optimal solution such that they would be able to predict and control Debt Equity incurrence and improve results.

Course Outcomes: At the end of this course students will demonstrate the ability to
1. The students would be able to understand and define basic terminology used in finance and accounts
2. The students would be able to prepare& appraise Financial Statements and evaluate a company in the light of different measurement systems.
3. The students would be able to analyze the risk and return of alternative sources of financing.
4. Estimate cash flows from a project, including operating, net working capital, and capital spending.
5. To estimate the required return on projects of differing risk ,to estimate the cash flows from an investment project, calculate the appropriate discount rate, determine the value added from the project, and make a recommendation to accept or reject the project
6. To describe and illustrate the important elements in project finance Using financial calculator and Excel in a variety of problems.

UNIT I: INTRODUCTION
Introduction to Financial Accounting, Book keeping & Recording: Meaning, Scope and importance of Financial Accounting. Financial Accounting - concepts and conventions, classification of accounts, Rules and principles governing Double Entry Book-keeping system, Meaning, Preparation of Journal, Ledger , Cash book & Trial balance.

UNIT II: FINANCIAL STATEMENT PREPARATION, ANALYSIS & INTERPRETATION
Preparation of financial statement and Profit & Loss Account, Balance Sheet. , Ratio Analysis - classification of various ratios.

UNIT III: INTRODUCTION TO FINANCIAL MANAGEMENT

Concept of business finance, Goals & objectives of financial management, Sources of financing, Long Term financing- shares, debentures, term loans, lease & hire purchase, retained earnings, public deposits, bonds (Types, features & utility). Short Term Financing- bank finance, commercial paper, trade credit

UNIT IV: WORKING CAPITAL MANAGEMENT

Concept of working Capital, significance, types. Adequacy of working capital, Factors affecting working capital needs, financing approaches for working capital, Methods of forecasting working capital requirements, Methods of Forecasting.

UNIT V: TIME VALUE OF MONEY & CAPITAL BUDGETING

Concept of time value of money, Compounding & discounting; Future value of single amount & annuity, present value of single amount & annuity; Practical application of time value technique. Capital budgeting - Nature and significance, techniques of capital budgeting –Pay Back Method, Accounting rate of return, Internal Rate of Return, DCF, Net Present Value and profitability index.

UNIT VI: PROJECT FINANCING

Details of the company, its promoters and project finances required, profitability etc., Loan documentation-Appraisal of terms loans by financial institutions. Basic components of project finance.

TEXT & REFERENCE BOOKS:

1. Financial Management by Khan & Jain, Text, Problem & Cases, Tata McGraw Hill Publication 5th Edition.
2. Tulsian Financial Management by Dr. P.C.Tulsian, S Chand Publication 5th Edition.
3. Taxman's Financial Management by Ravi M. Kishore, Taxmann 2017 Edition.
4. A Textbook of Financial , Cost & Management Accounting by Dr.P.Pariasamy, Himalaya Publishing House
5. Fundamentals of financial Management by Bhabhtosh Banerjee, PHI publication, 2nd Edition.

BTEEE705A: DIGITAL SIGNAL PROCESSING	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits:3	End Term Exam: 60 Marks

Prerequisite:

Digital Systems, Interfacing, Z-Transform, Fourier Transform

Course Objectives:

To understand the design and implementation of digital Signal processing systems

Course Outcomes:

After Completion of this Course, student will be able to
1. Represent signals, systems and digital processing of analog signals.
2. Represent discrete time signals, systems and analysis of Discrete-Time Linear Time-Invariant Systems.
3. Apply digital signal processing techniques to analyze discrete time signals in time domain.
4. Apply digital signal processing techniques to analyze discrete time signals in frequency domain.
5. Design different filter structure
6. Validate system functionality and evaluate results.

UNIT I: INTRODUCTION TO DIGITAL SIGNAL PROCESSING (8 hr)

Signals, Systems and Signal Processing: Basic Elements of a Digital Signal Processing System, Advantages of Digital over Analog Signal Processing.

Classification of Signals: Multichannel and Multidimensional Signals, Continuous-Time versus Discrete-Time Signals, Continuous-Valued Versus Discrete-Valued Signals, Deterministic Versus Random Signals.

The Concept of Frequency in Continuous-Time and Discrete-Time Signals: Continuous-Time Sinusoidal Signals, Discrete-Time Sinusoidal Signals, Harmonically Related Complex Exponentials.

Analog-to-Digital and Digital-to-Analog Conversion: Sampling of Analog Signals, the Sampling Theorem, Quantization of Continuous-Amplitude Signals, Quantization of Sinusoidal Signals, Coding of Quantized Samples, Digital-to-Analog Conversion, Analysis of Digital Signals and Systems versus Discrete-Time Signals and Systems.

UNIT II: DISCRETE-TIME SIGNALS AND SYSTEMS **(8 hr)**
Discrete-Time Signals: Some Elementary Discrete-Time Signals, Classification of Discrete-Time Signals, Simple Manipulations of Discrete-Time Signals.

Discrete-Time Systems: Input-Output Description of Systems, Block Diagram Representation of Discrete-Time Systems, Classification of Discrete-Time Systems, Interconnection of Discrete-Time Systems.

Analysis of Discrete-Time Linear Time-Invariant Systems: Techniques for the Analysis of Linear Systems, Resolution of a Discrete-Time Signal into Impulses, Response of LTI Systems to Arbitrary Inputs: The Convolution Sum, Properties of Convolution and the Interconnection of LTI Systems, Causal Linear Time-Invariant Systems, Stability of Linear Time-Invariant Systems, Systems with Finite-Duration and infinite-Duration Impulse Response.

Discrete-Time Systems Described by Difference Equations: Recursive and Nonrecursive Discrete-Time Systems, Linear Time-Invariant Systems Characterized by Constant-Coefficient Difference Equations, Solution of Linear Constant-Coefficient Difference Equations, The Impulse Response of a Linear Time-Invariant Recursive System

UNIT III: Z-TRANSFORM AND ITS APPLICATION TO THE ANALYSIS OF LTI SYSTEMS **(6 hr)**
Z-Transform: Direct z-Transform, Inverse z-Transform. Properties of z-transform. Rational z-Transforms: Poles and Zeros. Pole Location and Time-Domain Behavior for Causal Signals, System Function of a Linear Time-Invariant System. Inversion of the z-Transform: Inverse z-Transform by Contour Integration, Inverse z-Transform by Power Series Expansion, Inverse z-Transform by Partial-Fraction Expansion, Decomposition of Rational z-Transforms, One-sided z-Transform: Definition and Properties, Solution of Difference Equations.

UNIT IV: FREQUENCY ANALYSIS OF SIGNALS AND SYSTEMS **(4 hr)**
Properties of the Fourier Transform for Discrete-Time Signals: Symmetry Properties of the Fourier Transform, Fourier Transform Theorems and Properties.

UNITV:DISCRETE FOURIER TRANSFORM: PROPERTIES AND APPLICATIONS (8 hr)
Frequency Domain Sampling: The Discrete Fourier Transform: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, Discrete Fourier Transform (DFT), DFT as a Linear Transformation, Relationship of the DFT to Other Transforms. Properties of the DlT: Periodicity. Linearity and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties.

UNIT VI: IMPLEMENTATION OF DISCRETE- TIME SYSTEMS **(6 hr)**
Structures for the Realization of Discrete-Time Systems. Structures for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures, Lattice Structure.

Structures for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures, Latticc and Lattice-Ladder Structures for IIR Systems.

Reference Book:
1) John G. Proakis, Dimitris G.Manolakis, "Digital Signal Processing".
2) Shalivahanan, Vallavaraj and Gnanapriya, "Digital Signal Processing"

Text Book:
1) N.G.Palan, "Digital Signal Processing"
2) Ramesh Babu, "Digital Signal Processing"
3) Alon V. Oppenhelm, "Digitsl Signal Processing", PHI Pub.
4) S.K.Mitra, "Digital Signal Processing", TMH Pub.

BTEEE705B: ENERGY AUDIT AND CONSERVATION	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits:3	End Term Exam: 60 Marks

Pre Requisite:

Basics of Electrical Machines, Power Plant Engineering

Course Objectives:

1. To understand the basic process involved in the energy audit and the terminologies associated in the process.
2. To be able to develop audit reports of any firm including large and small scale industries, residential and commercial establishments.
3. To select and comment on the appropriate method for the planning and monitoring of any energy conservation project.

Course Outcomes:

After Completion of this Course, student will be able

1. To recognize Global Environmental Issues and Role of Renewable & non-conventional energy sources
2. To estimate Energy efficiency opportunities in Thermal- Mechanical Systems and Electrical System.
3. To analyze Energy Conservation Proposals economically and prepare audit reports.

UNIT I: SOURCES OF ENERGY: (6hr)
Energy resources, Stored & running resources, Environmental Concerns – Global Warning , Depletion of Ozone layer, Kyoto Protocol, UNFCCC, CDM, Carbon Emissions, Role of Renewable Energy Sources

UNIT II: (7hr)
Energy Conservation Act 2001, Designated Consumers, Energy Policy, BEE and its role in Energy Conservation, Energy Audit – Need, Types , Methodology, Steps involved in Energy Audit, Energy Costs and Benchmarking , Measurements for Energy Audit, Energy Management Duties and Responsibilities.

UNIT III: THERMAL MECHANICAL SYSTEMS (8hr)
Boiler Efficiency by direct and indirect methods, Energy efficiency opportunities in boilers, HVAC, and refrigeration systems, compressed air systems, pumps, cooling towers, fans and blowers, Cogeneration – Need and Principle , Prime movers for cogeneration, Waste heat recovery systems – Recuperators, economizer heat recovery boilers.

UNIT IV: ELECTRICAL SYSTEMS   (7hr)

Utilities: Energy conservation in generation, transmission,distribution & utilization, Electrical billing , load management ,maximum demand control, APFC Panel , PF improvement and benefits , Energy Efficient motors and starter, lightning systems, Electronic Ballast

UNIT V: (6hr)

Planning, Implementation & monitoring of energy conservation project, Time Value of money, Financial Investment – Simple payback period, ROI (Return on Investment), Net Present value, Internal rate of return, profitability index. All calculations and numerical interpretation.

UNIT VI: (6hr)

Case studies on various industrial sectors like Steel Plant, Thermal Plant, Industries Building and Commercial Establishments and preparing audit reports

Text Books:
1. "Industrial Energy Conservation" Charles M Gottschalk ,John Willey and Sons
2. "Energy Management" Paul O Callagham, Tata Mc Grawhill
3. "Energy Technology" – S Rao and B Parulekar , Khanna Publisher

References:
1. "Energy Management Handbook" – Wayne C Turner

BTEEE705C: ELECTRICAL POWER QUALITY	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits:3	End Term Exam: 60 Marks

Prerequisite:

1. Basic Electrical concepts
2. Power Electronics concepts
3. Power system concepts

Course Objectives:

1. To study the various power quality issues, their production, monitoring and mitigation.
2. To study the various power quality standards.
3. To study various power quality monitoring methods.
4. To apply appropriate solution techniques for power quality Problems.

Course Outcome:

After Completion of this Course….

1. Student will be able to get the in-depth understanding of power quality issues & standards.
2. Students will be able to understand working of power quality improving Equipment's.

UNIT I: INTRODUCTION (7hr)

Understanding Power quality, definitions, growing concerns to Power Quality, Evaluation Procedure,General Classes of Power Qualitydisturbances, causes and effects of Power Quality disturbances

UNIT II: TRANSIENT OVER VOLTAGES (7hr)

Sources, causes and effects, Principle of Overvoltage protection and solutions. VoltageSag and Interruptions: causes and effects, estimation of voltage sag performance, principle ofprotection and solutions.

UNIT III: LONG-DURATION VOLTAGE VARIATIONS (7hr)

Long Duration Voltage variations, principles of regulating voltage Devices for voltage regulation, flickers, flicker sources and mitigation, quantifying flicker.

UNIT IV: FUNDAMENTALS OF HARMONICS (7hr)

Harmonic distortion, sources of harmonics, effects of harmonic distortion, Voltage Vs Current Harmonics,Active, Reactive, Volt-Amp power under non sinusoidal conditions, Harmonic Indices (THD and TDD),principles of harmonic control, mitigating devices, interharmonics, IEEE standard 519.

UNIT V: WIRING AND GROUNDING (4hr)

Reasons for Grounding, wiring and grounding problems and solutions

UNIT VI: POWER QUALITY MONITORING (7hr)

Monitoring Considerations, site survey, Monitoring Quality, monitoring location, PQ measuringinstruments, assessment of power quality measurement data, IEEE 1159 Standard. Impact of poor power quality on Reliability Indices.

References/Books:
1.Chattopadhyay, Surajit, Mitra, Electric Power Quality, Springer.
2.Haytt G. T., ―Electric Power Quality‖, Stars In Circle Publication.
3. NPTEL courses
   a) NOC:Power Quality Improvement Technique, IIT Roorkee by Avik Bhattacharyya.
   b) Power Quality in Power Distribution Systems, IIT Madras by Dr. Mahesh Kumar.

BTEEE705D: HVDC TRANSMISSION AND FACTS	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20 Marks
Tutorial:	Internal Assessment: 20 Marks
Total Credits: 3	End Term Exam: 60 Marks

Pre requisite: Power System-II, Power Electronics

Course Outcome:

1. To understand importance, configuration and types of HVDC transmission.
2. To analyst the operation of HVDC converter, system control and protection.
3. To understand the concept of FACTS, their role, type and functionality.
4. To analyze the operation of static series and shunt compensator.

UNIT I: DC POWER TRANSMISSION FUNDAMENTALS (8hr)

Introduction, Economics of Dc Power transmission, comparison with AC system, Types of DC links, major components of converter station, planning of HVDC system.

UNIT II: HVDC CONVERTER (6hr)

Choice of converter configuration, analysis of Gratz circuit with and without overlap, working of converter as rectifier and inverter, equivalent circuit for HVDC link

UNIT III: HVDC SYSTEM CONTROL (6hr)

HVDC System Control: Principles of DC link control, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of HVDC link

UNIT IV: CONVERTER FAULTS AND PROTECTION (6hr)

Converter Faults and Protection: Types of faults-commutation failure, Arc through, Misfire, short circuit in bridge, Over current and over voltage protection, Detection of line faults, Principle of DC circuit interruption, DC breakers, Types and characteristics of DC breakers, effects of proximity of AC and DC transmission lines.

UNIT V: FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATIONS (6hr)

Transmission Interconnections, Flow of Power in an AC System, Loading Capability limits, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic types of FACTS Controllers, Description and Definitions of FACTS Controllers, Benefits from FACTS Technology, Comparison between HVDC & FACTS.

UNIT VI: STATIC SHUNT COMPENSATORS (6hr)

Static Shunt Compensators: Objective of shunt compensation, Methods of Controllable VAR Generation, Static VAR Compensators: SVC and STATCOM, Comparison of SVC and

STATCOM, Static VAR Systems (SVS)Static Series Compensation: Objective of series compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators

References
1. Padiyar K. R., "HVDC Power Transmission Systems", New Age International.
2. Kimbark, " HVDC Transmission", John Willey AndSons.
3. Hingorani N. G., " Understanding FACTS", IEEE Press2001
4. Yong Hua Song, ' Flexible AC transmission systems(FACTS)'IEEE

BTEEL706: POWER SYSTEM OPERATION AND CONTROL LAB	
Teaching Scheme:	Examination Scheme:
Practical: 2hr	Continuous Assessment: 30 Marks
Total Credits: 1	End Term Exam: 20 Marks

Sr. No.	List of the Experiment
1	Write a program for economic dispatch in power systems using
2	Simulation of Automatic voltage regulator using MATLAB.
3	Write a program to compute the voltage and power factor for a given system using MATLAB.
4	Write a program to solve Swing Equation by Classical Method.
5	Write a program to plot power angle curve of synchronous machine using MATLAB.
6	Write a program to solve the given Equal Area Criteria problem using MATLAB.
7	To demonstrate the Excitation System for Synchronous machine using MATLAB
8	Simulation of single area load frequency control using MATLAB.

BTEEL707: HIGH VOLTAGE ENGINEERING LAB	
Teaching Scheme:	Examination Scheme:
Practical: 2hr	Continuous Assessment: 30 Marks
Total Credits: 1	End Term Exam: 20 Marks

Sr. No.	List of Experiment
1	Study of Faraday Cage for HV labs.
2	Study of Standard HV Laboratory layouts.
3	One min. (1-min.) DC high voltage withstand test on Equipment. (Max. up to 10 KV).
4	Effect of gap length on liquid insulating material.
5	Breakdown Strength of composite dielectric material.
6	Study of impulse generator.
7	High voltage withstand test on cables/safety gloves/shoes, as per IS. (Max. 2.25 KV DC)
8	Horn gap arrangement as surge diverter.
9	Measurement audible and visible corona inception and extinction voltage
10	Development of tracks and trees on polymeric insulation.
11	Study of Effect of EHV field on Human, Animals & Plants.

BTEEL708: ELECTRICAL DRIVES LAB	
Teaching Scheme:	Examination Scheme:
Practical: 2hr	Continuous Assessment: 30 Marks
Total Credits: 1	End Term Exam: 20 Marks

Pre requisite	Basic electronics engineering, basic electronics engineering Course
Course Outcome	• Efficiently use various AC and DC drive. • Simulate various drive system
Sr.No	List of Experiments
1	Study the ramp comparator firing circuit.
2	Study of single phase half wave converter and semi converter DC Drive .
3	Study of single phase full controlled converter (Bridge converter) DC Drive.
4	Speed control of DC motor using chopper.
5	Simulation of single phase half wave and semiconductor controlled DC drive.
6	Simulation of chopper fed DC Drive .
7	Study of AC Drive .
8	Study of V/f control of AC drive
9	Study the inverter fed induction motor drive.
10	Simulation of AC drive .

BTEES709: SEMINAR	
Teaching Scheme:	Examination Scheme:
Practical: 2hr	Continuous Assessment: 30 Marks
Total Credits: 1	End Term Exam: 20 Marks

Student shall choose a topic of his/her interest in consultation with faculty in the department. The topic for seminar may be related to Recent Developments in Instrumentation Engineering area and/or interdisciplinary area. Student shall attempt to collect necessary information and present a summary indicating comprehension of the topic and acquired depth of knowledge. A brief report on topic of seminar shall be submitted. Evaluation shall be based on report and power point presentation.

BTEEP710: PROJECT PART-I	
Teaching Scheme:	Examination Scheme:
Practical: 6hr	Continuous Assessment: 30 Marks
Total Credits: 3	End Term Exam: 20 Marks

Term work shall consist of detailed report for chosen topic and output of final working proposed. Report shall summarize the literature survey, spell out the scope of work, methodology and results. Viva-voce Examination shall be based on work carried out by the student. In case of students opting for Internship in the eighth semester, the Project may be industry-based.

BTEEF711: FIELD TRAINING/INTERNSHIP/INDUSTRIAL TRAINING III	
Teaching Scheme:	Examination Scheme:
Practical: --	Continuous Assessment: --
Total Credits: 1	End Term Exam: 50 Marks

Students are expected to undergo industrial training for at least four weeks at factory / design offices or in combination of these after VI semester. Training session shall be guided and certified by qualified engineer / industry expert. A neat detailed report on activities carried out during training is expected. Students should undergo training in Summer Vacation after Semester VI and appear at examination in Semester VII. A brief report of industrial training shall be submitted. Evaluation shall be based on report and power point presentation.

POWER MANAGEMENT INTEGRATED CIRCUITS	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20* Marks
Total Credits: 3	Internal Assessment: 20* Marks
	End Term Exam: 60* Marks

Prof. Qadeer Ahmad Khan | IIT Madras
Course Duration: 12 weeks

CourseOutline:

This course is intended to develop understanding of why power management circuits are needed in a VLSI system, what are the different components of a power management system with focus on voltage regulators. By the end of this course, students should be able to understand the concept behind power management circuits and design a linear (LDO) and switching regulator (dc-dc converter) for a given specifications using behavioral and circuit level simulators.

Course Plan:

Week 1 : Introduction to Power Management - Application, Need, Discrete vs. Integrated PMIC; DC-DC Converters, Types of DC-DC Converters, Linear versus Switching Regulator, Choosing between Linear and Switching Regulators, Choosing the Type of Regulator in a Multi-Chip System; Performance Parameters - Efficiency, Accuracy, Line and Load Regulation, Line and Load Transient, PSRR; Remote versus Local Feedback, Point-of-Load Regulator, Kelvin Sensing, Droop Compensation; Current Regulators and their Applications; Bandgap Voltage Reference - Designing a Bandgap Reference using PTAT and CTAT Voltage References, Brokaw Bandgap Circuit.

Week 2: Sub-1-volt Bandgap Reference; Introduction to Linear Regulator, Applications of Linear Regulator; Review of Feedback Systems and Bode Plots, Loop Gain AC Analysis, Stability Criterion and Phase Margin, Review of First-Order and Second-Order Systems, Relationship between Damping Factor and Phase Margin; Parasitic Capacitances in a MOS transistor, Finding the Poles of the Error Amplifier; Stabilising a Linear Regulator - Frequency Compensation Techniques, Dominant Pole Compensation.

Week 3 : Miller Compensation, R.H.P. zero due to Miller Compensation, Intuitive Methods of Determining Poles and Zeros after Miller Compensation, Pole Splitting due to Miller Compensation, Reducing the Effect of R.H.P. zero; LDO with NMOS Pass Element; Load Regulation and Output Impedance of LDO; Line Regulation and PSRR of LDO; Sources of Error in a Regulator, Static Offset Correction, Dynamic Offset Cancellation.

Week 4 : Digital LDO, Avoidance of Limit-Cycle Oscillations in a Digital LDO, Hybrid LDO; Short-Circuit Protection and Foldback Current Limit in an LDO; Basic Concept of a Switching Regulator, Inductor volt-second Balance, Power Stage of a Buck Converter and Calculation of Duty Cycle; Transformer Model of a Buck Converter, Resistive Losses, Efficiency of a Switching Regulator, Efficiency considering only Conduction Losses; Synchronous and Non-Synchronous Switching Converters; PWM Control Techniques (Voltage-Mode and Current-

Mode Control); Losses in Switching DC-DC Converter- Conduction Loss, Gate-Driver Switching Loss, Segmented Power FETs, Dead-Time Switching Loss.

Week 5 : Hard Switching Loss, Magnetic Loss, Relative Significance of Losses as a Function of the Load Current; Inductor Current Ripple and Output Voltage Ripple in a DC-DC Converter, Ripple Voltage versus Duty Cycle, Ripple Voltage versus Input Supply Voltage; Choosing the Inductor and Capacitor of a Buck Converter; Continuous and Discontinuous Conduction Modes - Boundary Condition, Voltage Conversion Ratio in DCM; Concept of Pulse Frequency Modulation (PFM); Classification of Pulse Width Modulators -- Trailing, Leading and Dual-Edge PW Modulators; Control Techniques for DC-DC Converters; Voltage Mode Control, Small-Signal Modeling of a DC-DC Converter, Loop Gain and Stability Analysis using Continuous-Time Model.

Week 6 : Compensating a Voltage-Mode-Controlled Buck Converter; Designing Type-I (Integral), Type-II (PI) and Type-III (PID) Compensators; Implementation of Compensators using Op Amp-RC and Gm-C Architectures, Finding Compensation Parameters; Design Examples with Simulation Demonstrations.

Week 7 : Designing Type-III Compensator using Gm-C Architecture and Design Example; Ramp Generator with Feed-Forward Line Compensation, Loop Gain Compensation via Gm-modulation; Designing a Buck Converter - Power Loss Budgeting, Sizing of Power FETs, Estimation of Switching Losses and Choice of Switching Frequency, Choosing the External Passive Components (L and C); Choice of C in Relation to Factors that Limit the Load Transient Response; Inductor and Capacitor Characteristics, Reducing the Effect of Capacitor ESL.

Week 8 : Designing the Gate-Driver (Gate Buffer and Non-Overlap Clock Generator), Designing the Ramp Generator in a Pulse-Width Modulator, Design Considerations of the Error Amplifier; Delays Associated with Pulse-Width Modulators; PFM/PSM for Light Load, Using PSM in CCM to Avoid Duty Cycle Saturation; DCM Operation using an NFET; Designing a Zero-Cross Detector/Comparator; Introduction to Current Mode Control; Peak, Valley and Average CMC; Sub-Harmonic Oscillations, Avoiding Current Loop Instability via Slope Compensation in a Current-Mode-Controlled Buck Converter.

Week 9 : Non-Linear Control Techniques for DC-DC Converters; Hysteretic Control - Stability Issues due to Phase Shift between Inductor Current and Capacitor Voltage; Voltage-Mode versus Current-Mode Hysteretic Control, Stabilising a Voltage-Mode-Controlled Hysteretic Converter using R_esr, Relation between Hysteresis Window and Switching Frequency, Using R-C Circuit as Ripple Generator in a Current-Mode-Controlled Hysteretic Converter, Hybrid Voltage-Mode and Current-Mode Hysteretic Control, Fixed-Frequency Hysteretic Control, Effect of Loop Delay, Frequency-Regulation and Voltage-Regulation Loops in a Fixed-Frequency Hysteretic Converter; Constant ON/OFF-Time Control; Basic Concept of a Boost Converter, RHP zero in a Boost Converter.

Week 10 : Introduction to the Buck-Boost Converter, Tri-Mode Buck-Boost Converter, Boundary Conditions for Mode Transition in a Tri-Mode Buck-Boost Converter, Generation of Buck and Boost Duty Cycles; Introduction to Switched-Capacitor DC-DC Converters,

Applications of SC DC-DC Converters in Open-Loop, Output Regulation in SC DC-DC Converters using Feedback Control, H-Bridge SC DC-DC Converter, Multiple Gain Settings in SC DC-DC Converters; Current-Sensing Techniques in DC-DC converters.

Week 11 : Selecting the Process Node for a PMIC, Chip-Level Layout and Placement Guidelines, Board-Level Layout Guidelines, EMI Considerations; Introduction to Advanced Topics in Power Management --- Digitally-Controlled DC-DC Converters, Adaptive Compensation Techniques, Limitations of Analogue and Digital Controllers, Time-Based Control Techniques and their Drawbacks, Multi-Phase DC-DC Converters; Dynamic Voltage and Frequency Scaling (DVFS); Single-Inductor Multiple-Output (SIMO) DC-DC Converters.

Week 12 : Introduction to Advanced Topics in Power Management (continued) - DC-DC Converters for LED Lighting, LCD/AMOLED Display Drivers, LED Drivers for Camera Flash, Lithium-ion Battery and its Charging Phases, Battery Charger ICs.

DC POWER TRANSMISSION SYSTEM	
Teaching Scheme:	Examination Scheme:
Theory: 03	Mid-term Test: 20* Marks
Tutorial: 00	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof. Krishna S, IIT Madras
Course Duration: 12 weeks

CourseOutline:

This course gives an introduction to the DC power transmission system using the conventional line commutated converters. The topics covered include a detailed analysis of the 6 pulse line commutated converter (LCC), 12 pulse LCC, capacitor commutated converter, DC link control, and design of single tuned filter.

Course Plan:
Week 1: Introduction, choice of converter configuration
Week 2: Converter configuration for pulse number equal to 6, analysis of 6 pulse LCC neglecting overlap
Week 3: Fourier series, analysis of 6 pulse LCC neglecting overlap
Week 4: 2 and 3 valve conduction mode of 6 pulse LCC
Week 5: Extinction angle, 3 and 4 valve conduction mode and 3 valve conduction mode of 6 pulse LCC
Week 6: Commutation margin angle, normalization, characteristics of 6 pulse LCC, steady state analysis of a general LCC
Week 7: 6 pulse LCC with other circuits on the AC and DC sides
Week 8: Capacitor commutated converter, 12 pulse LCC
Week 9: Mode of operation of 12 pulse LCC, purposes of transformer, applications of DC transmission, types of DC link, DC link control
Week 10: Converter control characteristics, MTDC systems, non-characteristic harmonics
Week 11: Design of single tuned filter
Week 12: Double tuned and damped filters, reactive power requirement, comparison of AC and DC transmission

HIGH POWER MULTILEVEL CONVERTERS	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20* Marks
Tutorial:	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof. Anandarup Das, IIT Delhi
Course Duration: 12 weeks

CourseOutline:

The course covers different types of high power converters used in the industry for applications in HVDC, FACTS, Motor Drives, Power quality improvement. Traditional converters like NPC and emerging converters like modular multilevel converters will be covered. Operational issues and design considerations for these medium/high voltage high power converters will be covered. The course will discuss many practical issues faced in the industry while designing and operation of these converters.

Course Plan:

Week 1 : (a) Half bridge, Full bridge and three phase converters, sinusoidal PWM

Week 2 : (a) 3rd harmonic addition, space vector PWM

Week 3 : (a) Different types of multilevel converters
      (b) Cascaded H-Bridge converter – Basic operation

Week 4 : (a)PWM Techniques for CHB converter
      (b) Fault tolerant operation of CHB converter

Week 5 : (a) Modular Multilevel converter- Topology, operation and PWM

Week 6 : (a) Capacitor voltage balancing in MMC
      (b) Design of components of MMC

Week 7 : (a) NPC converter – Basic operation
      (b) NPC (3 level) Space vector diagram

Week 8 : NPC - PWM technique and midpoint balancing

Week 9 : (a) Case study of High Power converters for Motor drive and HVDC application

Week 10 : (a) Multi –pulse transformers

Week 11 : (a) Gate Drive circuit designing, protection and condition monitoring in high power converters
Week 12 : (a) Other topologies : conclusion

FUZZY SETS, LOGIC AND SYSTEMS & APPLICATIONS	
Teaching Scheme:	**Examination Scheme:**
Theory: 3hr	Mid-term Test: 20* Marks
Tutorial:	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof. Nishchal Kumar Verma, IIT Kanpur
Course Duration: 12 weeks

CourseOutline:

The course is designed to give a solid grounding of fundamental concepts of fuzzy logic and its applications. The level of the course is chosen to be such that all students aspiring to be a part of computational intelligence directly or indirectly in near future should get these concepts.

Course Plan:

Week 1 : Introduction and Fuzzy Sets Theory

Week 2: Membership Functions

Week 3: Set Theoretic Operations

Week 4: Fuzzy Arithmetic

Week 5: Fuzzy Relations

Week 6: Fuzzy Inference Systems I

Week 7: Fuzzy Inference Systems II

Week 8: Wang and Mendel Model

Week 9: TSK Model

Week 10: Fuzzifiers and Defuzzifiers

Week 11: ANFIS Architecture

Week 12: Fuzzy Systems and Machine Learning

THE JOY OF COMPUTING USING PYTHON	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20* Marks
Tutorial: 1hr	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof.Sudarshan Iyengar, Department of Computer Science and Engineering, IIT Ropar
Course Duration: 12 weeks

CourseOutline:

ThisisamostfundamentalDigitalCircuitDesigncourseforpursingamajorinVLSI. We do not deal with any Verilog coding during this course and instead discuss transistor level circuit design concepts in greatdetail.

Learning objectives of this course are:

- Characterize the key delay quantities of a standardcell
- Evaluate power dissipated in a circuit (dynamic andleakage)
- Design a circuit to perform a certain functionality with specifiedspeed
- Identify the critical path of a combinationalcircuit
- Convert the combinational block to pipelinedcircuit
- Calculate the maximum (worst case) operating frequency of the designedcircuit

Course Plan:

Motivation for Computing
Variables and Expressions: Design your own calculator
Loops and Conditionals: Hopscotch once again
Lists, Tuples and Conditionals: Let's go on a trip
Abstraction Everywhere: Apps in your phone
Counting Candies: Crowd to the rescue
Birthday Paradox: Find your twin
Google Translate: Speak in any Language
Currency Converter: Count your foreign trip expenses
Monte Hall: 3 doors and a twist
Sorting: Arrange the books
Searching: Find in seconds
Substitution Cipher: What's the secret !!
Sentiment Analysis: Analyse your Facebook data
20 questions game: I can read your mind
Permutations: Jumbled Words
Spot the similarities: Dobble game
Count the words: Hundreds, Thousands or Millions.
Rock, Paper and Scissor: Cheating not allowed !!
Lie detector: No lies, only TRUTH

Calculation of the Area: Don't measure.
Six degrees of separation: Meet your favourites
Image Processing: Fun with images
Tic tac toe: Let's play
Snakes and Ladders: Down the memory lane.
Recursion: Tower of Hanoi
Page Rank: How Google Works !!

INTRODUCTION TO INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS	
Teaching Scheme:	**Examination Scheme:**
Theory: 3hr	Mid-term Test: 20* Marks
Tutorial:	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof. SudipMisra, IIT Kharagpur
Course Duration: 12 weeks

CourseOutline:

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.

Course Plan:
Week 1 : Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II
Week 2 : Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories
Week 3 : Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis
Week 4 : Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems.
Week 5 :IIoT-Introduction, Industrial IoT: Business Model and RefereceArchiterture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II.
Week 6 : Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I.
Week 7 : Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III.
Week 8 : Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop.
Week 9 : Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II.
Week 10 : Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.
Week 11 : Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory

Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Week 12 : Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies :

Case study - I : Milk Processing and Packaging Industries
Case study - II: Manufacturing Industries - Part I
Case study - III : Manufacturing Industries - Part II
Case study - IV : Student Projects - Part I
Case study - V : Student Projects - Part II
Case study - VI : Virtual Reality Lab
Case study - VII : Steel Technology Lab

ENTREPRENEURSHIP ESSENTIALS	
Teaching Scheme:	Examination Scheme:
Theory: 3hr	Mid-term Test: 20* Marks
	Internal Assessment: 20* Marks
Total Credits: 3	End Term Exam: 60* Marks

Prof. Manoj Kumar Mondal, IITKharagpur
Course Duration: 12 weeks

CourseOutline:

The course provides foundational knowledge on various aspects of entrepreneurial venture creation and management during its life-cycle. It has been designed to address multidisciplinary audiences. The objective of the course is to teach key issues faced by entrepreneurs and managers at different stages of the life-cycle of an enterprise and is relevant both for aspiring entrepreneurs and for decision makers in established enterprises. Topics can be classified in some major themes such as : Making a choice to create an entrepreneurial venture, current trend of technology entrepreneurship, how to start a start-up, identifying opportunities, factors driving competitive advantages, organizational structure, basic knowledge of financial statements and project report,introductory knowledge on marketing management, human resource management, & strategic management, risk analysis, legal aspect of business, how to raise fund during life-cycle of a new ventures.

Course Plan:
Week 1 :   Introduction
             DhirubhaiAmbani& Sofia
             Myths & Realities about entrepreneurship
             entrepreneurial qualities
             Why start-ups fail?
Week 2:   Mission, vision, entrepreneurial qualities – I
             Mission, vision, entrepreneurial qualities – II
             Value proposition
             Business Model canvas
             Business model generation
Week 3:   Competitive advantage
             Lean start-up – 1
             Lean start-up – 2
             Team and early recruit
             Legal forms of business
Week 4:   Marketing management 1
             Marketing management 2
             Market research –I
             Market research –II
             Market research –Example
Week 5:   Introduction to financial statements
             Profit & Loss statement
             Balance sheet

Cash flow
Example – 1
Example – 2
Cost-volume-profit & Bread-Even analysis
Capital budgeting
Week 6: Business plan-I
Business plan-II
Pitching
Go-to-market strategies
Does & Don'ts
Week 7: How to innovate
Design Thinking
Design-Driven Innovation, Systems thinking
Open innovation, TRIZ
How to start a start-up?
Week 8: Government incentives for entrepreneurship (1 lecture)
Incubation, acceleration
Funding new ventures – bootstrapping, crowd sourcing,
angel investors, VCs, debt financing (3), due diligence
Legal aspects of business (IPR, GST, Labour law)
Week 9: Cost, volume, profit and break-even analysis
Margin of safety and degree of operating leverage
Capital budgeting for comparing projects or opportunities
Product costing
Product pricing
Week 10: Funding new ventures – bootstrapping, crowd sourcing,
Angel investors, VCs, debt financing (3), and due diligence
Incubation and acceleration
Government incentives for entrepreneurship
Project cost and Financial Closure
Week 11: Dos &Donts in entrepreneurship
Growth Hacking
Growth Strategy
Legal aspects of business (IPR, GST, Labor law)
Negotiation skill
Week 12: Human Resource management in startups
Pivoting
Entrepreneurial cases
Risk assessment and analysis
Strategy management for entrepreneurial ventures
Factors driving success and failure of ventures
Concluding remarks

BTEEP803: PROJECT-II	
Teaching Scheme:	Examination Scheme:
Practical: 30hr	Continuous Assessment: 100 Marks
Total Credits: 15	End Term Exam: 150 Marks

Since Project Stage II is in continuation to Project Stage I, the students are expected to complete the total project by the end of semester VIII. After completion of project work, they are expected to submit the consolidated report including the work done in stage I and stage II.

The report shall be comprehensive and presented typed on A4 size sheets and bound. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oral examinations.