IKG Punjab Technical University

Teaching Scheme

(3^{th} - 8^{th} Semester)

for

Undergraduate Degree Programme

Bachelor of Technology

in

ELECTRICAL & ELECTRONICS ENGINEERING

2018 & onwards

Semester III [Second year]						Branch: Electrical & Electronics Engineering				
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEEE-301-18/ BTEE-301-18	Electrical Circuit Analysis	3	1	0	4	40	60	100	4
2	BTEEE-302-18/ BTEE-302-18	Analog Electronics	3	0	0	3	40	60	100	3
3	BTEEE-303-18/ BTEE-302-18	Electrical Machines – I	3	0	0	3	40	60	100	3
4	BTEEE-304-18/ BTEE-304-18	Electromagnetic Fields	3	1	0	4	40	60	100	4
5	BTEE-305-18	Engineering Mechanics	3	1	0	4	40	60	100	4
6	BTEEE-311-18/ BTEE-311-18	Analog Electronics Laboratory	0	0	2	2	30	20	50	1
7	BTEEE-312-18/ BTEE-312-18	Electrical Machines – I Laboratory	0	0	2	2	30	20	50	1
8	BTMC-XXX-18	Mandatory Course (BTMC-101-18 or BTMC 102-18)	3	0	0	3	40	60	100	S/US
9	BMPD-301-18	Mentoring and Professional Development of Students	0	1	0	1	50	-	50	S/US
10	BTEEE-321-18	Institutional Summer Vacation Training*	-	-	-	35*	-	-		S/US
		Total	**18**	**4**	**4**	**26**	**350**	**400**	**750**	**20**

Semester IV [Second year]							**Branch: Electrical & Electronics Engineering**			
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEEE-401-18/ BTEE-401-18	Digital Electronics	3	0	0	3	40	60	100	3
2	BTEEE-402-18/ BTEE-402-18	Electrical Machines – II	3	0	0	3	40	60	100	3
3	BTEEE-403-18/ BTEE-403-18	Power Electronics	3	0	0	3	40	60	100	3
4	BTEEE-404-18/ BTEE-404-18	Signals and Systems	3	0	0	3	40	60	100	3
5	BTAM-302-18	Mathematics-III (Probability & Statistics)	3	1	0	4	40	60	100	4
6	BTEEE-411-18/ BTEE-411-18	Measurements and Instrumentation Lab.	2	0	2	4	30	20	50	3
7	BTEEE-412-18/ BTEE-412-18	Digital Electronics Laboratory	0	0	2	2	30	20	50	1
8	BTEEE-413-18/ BTEE-413-18	Electrical Machines – II Laboratory	0	0	2	2	30	20	50	1
9	BTEEE-414-18/ BTEE-414-18	Power Electronics Laboratory	0	0	2	2	30	20	50	1
10	BTMC-XXX-18	Mandatory Course (BTMC-101-18 or BTMC 102-18)	3	0	0	3	40	60	100	S/US
11	BMPD-401-18	Mentoring and Professional Development of Students	0	1	0	1	50	-	50	S/US
Total			**20**	**2**	**8**	**30**	**410**	**440**	**850**	**22**
Students to undertake Six weeks summer industry internship/ field training (during vacation).										

Additional Lectures/Tutorials: Need based additional lectures/tutorials may be introduced of any Course, however, the Credits of the course will not change.

BTEEE-321-18: Institutional Summer Vacation Training: Four (04) weeks Institutional Summer Vacation Training after 2nd semester for programme. B. Tech. (Electrical & Electronics Engineering)

Objective: The training is compulsory and is for the orientation of the students of Electrical & Electronics Engineering so that they are aware of/can identify the industrial, departmental, environmental, societal and other issues that are a challenge in the society and develop the ability to find solutions. The training in the concerned discipline will be provided in College/Department Labs /Workshops.

Content to be covered:

Module I, II & III: Hands on training/ practical knowledge on any three/four of the given contents

Module IV & V: Compulsory

Module	Content	Remarks
I	• Hands on training of wiring (Tube light, Incandescent bulb & LED light fitting, extension board, staircase). • Preparation of wiring diagram for domestic load/commercial load • Study of types of switches, protective devices (samples to be made available) • Types of electrical wires and Cables (samples to be made available) • Classification of Insulation (samples to be made available)	30 hours
II	• Single Line diagram of power generation, transmission distribution • Power scenario in India (Conventional & renewable sources of energy) (recent information from the website of Ministry of power to be included) • Introduction to the concept of Heating, Ventilation and Air conditioning. • The need of industrial safety. • Introduction to electrical machines and their maintenance.	30 hours
III	• Introduction to multimeter, function generator, CRO, • Identification and testing of resistors, capacitors, transistors and diodes, etc. • Observing the response of various circuits on CRO • Design and fabrication of +5V / +12V powers supply on bread board • Design and fabrication of half wave and/or full wave rectifier • Logics gates (using ICs)	30 hours
IV	• Study of main components of a sub-station and visit to local sub Station • Visit to industry/manufacturing unit related to discipline/branch (In case of small-scale industries/MSMEs, the faculty and students to identify small issues and propose requisite solutions/ remedies/ innovative solutions based on engineering) • Invited talk by Industry Expert • Expert talk on recent technologies	25 hours

Module	Content	Remarks
V	• Visit to local NGO/village/city to identify socio-economic/ environmental issues and identify a problem and prepare a "Problem formulation report" • To have a group discussion on the issues identified with faculty and to propose requisite solutions/remedies/innovative solutions based on Engineering.	25 hours
Total Time		140 hours

Evaluation Criterion:

i) Four (04) weeks Institutional Summer Vacation Training after 2nd semester is a compulsory non-Credit course.
ii) The students are required to maintain a daily dairy and submit it along with the "Problem formulation report".
iii) Student falling short of 75% attendance criterion is required to repeat the training with next batch.
iv) Continuous evaluation to be done and proper record to be maintained.
v) The result will be "Satisfactory/Unsatisfactory" which is to be recorded within 3 working days after the completion of the training.

BTEEE-521-18	Summer Industry Internship/ Field Training	(Non-Credit)

Six weeks in an Industry in the area of Electrical & Electronics Engineering during summer vacations after 4th semester. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. The student will make a presentation based upon the Industry Internship attended. Performance to be rated as Satisfactory/Un -Satisfactory (S/US). For unsatisfactory the internship to be repeated.

Evaluation scheme (Summer Industry Internship/ Field Training)

Internal ***(to be evaluated by Industry)***	***Marks***	***External**** ***(to be evaluated by Department)***	***Marks***
Attendance	15	Daily Dairy	5
Performance (Work done /simulation/hardware/project developed)	30	Report	10
Report	10	Presentation (Work done /simulation/hardware/project developed)	25
Daily Dairy	05		
Total	***60***	***Total***	***40***

*External examiner not to be called.

Range of credits for Honors Degree -Minimum credits as per scheme are required by a student to be eligible to get Under Graduate degree in Electrical & Electronics Engineering. A student will be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits. These could be acquired through MOOCs and registering in the department.

Range of Credits and Courses for Major Degree in B. Tech. (Electrical & Electronics Engineering) and Minor Degree in B.Tech. (Electrical and Computer Engineering)

(i) A student admitted in B. Tech (Electrical & Electronics Engineering) may opt for Major Degree in B.Tech. (Electronics & Electrical Engineering) and Minor Degree in B.Tech. (Electrical and Computer Engineering) with effect from 3rd semester onwards.
(ii) The student must clear his/her previous two semesters (1st semester and 2nd semester).
(iii) The student/candidate will require to clear at least five theory subjects for Minor Degree in B.Tech.
(iv) The minimum credits for Minor Degree in B. Tech. will be 20 in which the student will have to clear minimum two (2) Core Courses and three (3) Professional Elective (PE) Courses / Core Courses).
(v) A student is permitted to take maximum 8 credits (theory + lab) per semester pertaining to their Minor Degree in B.Tech.

Virtual Laboratories: Students may take at least one virtual laboratory any time before the commencement of the 8th Semester.

Open Elective: A student may take Courses from the list of Open Electives offered by other Departments or MOOCs Courses of SWAYAM/MOOCs courses approved by the Board of Studies.

MANDATORY COURSES (Non-Credit Courses)

Sr. No.	Semester	Course Code	Course Title	Hours/Week	Credits
1.	III/IV	BTMC-101-18	Indian Constitution	3L:0T:0P	Nil
2.	III/IV	BTMC-102-18	Essence of Indian Traditional Knowledge	3L:0T:0P	Nil
3.	V	EVS 101-18	Environmental Studies	2L:0T:0P	Nil

Students to undertake Six Weeks Summer Industry Internship (during vacation).

Semester V [Third year]			Branch: Electrical & Electronics Engineering						
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-501-18	Power Systems – I (Apparatus & Modelling)	3	1	0	4	40	60	100	4
2	BTEE-502-18	Control Systems	3	1	0	4	40	60	100	4
3	BTEE-503-18	Microprocessors	3	1	0	4	40	60	100	4
4	BTXXX-504X-18	Programme Elective-1	3	0	0	3	40	60	100	3
5	EVS-101-18	Environmental Studies	2	0	0	2	50	-	50	S/US
6	BTEE-511-18	Power Systems-I Laboratory	0	0	2	2	30	20	50	1
7	BTEE-512-18	Control Systems Laboratory	0	0	2	2	30	20	50	1
8	BTEE-513-18	Microprocessors Laboratory	0	0	2	2	30	20	50	1
9	BTEEE-521-18	Summer Industry Internship	-	-	-	-	40	60	100	S/US
10	BMPD-501-18	Mentoring and Professional Development of Students	0	1	0	1	50	-	50	S/US
		Total	**14**	**4**	**6**	**24**	**390**	**360**	**750**	**18**

Semester VI [Third year]						Branch: Electrical & Electronics Engineering				
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-601-18	Power Systems – II (Operation and Control)	3	1	0	4	40	60	100	4
2	BTELE-602-18	Digital Signal Processing	3	1	0	4	40	60	100	4
3	BTXXX-603X-18	Programme Elective-2	3	0	0	3	40	60	100	3
4	BTXXX-604X-18	Programme Elective-3	3	0	0	3	40	60	100	3
5	OXX-XXX-18	Open Elective-1	3	0	0	3	40	60	100	3
6	HSMC-XXX-18	Humanities & Social Sciences including Mgt.	3	0	0	3	40	60	100	3
7	BTEE-611-18	Electronic Design Laboratory	1	0	2	3	30	20	50	2
8	BTEE-612-18	Power System II Laboratory	0	0	2	2	30	20	50	1
9	BTEEE-621-18	Minor Project	0	0	6	6	60	40	100	3
10	BMPD-601-18	Mentoring and Professional Development of Students	0	1	0	1	50	-	50	S/US
		Total	**19**	**3**	**10**	**32**	**410**	**440**	**850**	**26**

Institute/Department to decide regarding sending students for One Semester Training in 7th or 8th Semester.										
Semester VII/VIII [Fourth year]					**Branch: Electrical & Electronics Engineering**					
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTXXX-701X-18	Programme Elective-4	3	0	0	3	40	60	100	3
2	BTXXX-702X-18	Programme Elective-5	3	0	0	3	40	60	100	3
3	BTXXX-703X-18	Programme Elective-6	3	0	0	3	40	60	100	3
4	OXX-XXX-18	Open Elective-2	3	0	0	3	40	60	100	3
5	OXX-XXX-18	Open Elective-3	3	0	0	3	40	60	100	3
6	HSMC-XXX-18	Humanities & Social Sciences including Mgt.	3	0	0	3	40	60	100	3
7	BTEE-721-18/ BTEEE-721-18	Project-2	0	0	12	12	120	80	200	6
8	BMPD-701-18	Mentoring and Professional Development of Students	-	1	0	1	50	-	50	S/US
Total			**18**	**1**	**12**	**31**	**410**	**440**	**850**	**24**

Institute/Department/Student may decide for Industry oriented courses in lieu of One Semester Training in 7th or 8th Semester (Subject to approval from Competent Authority).

Semester VII/VIII [Fourth year]					**Branch: Electrical & Electronics Engineering**		
BTEEE-721-18/ BTEE-721-18/ One Semester Training	**Marks**					**Total Marks**	**Credits**
	Internal				**External**		
	Mid- semester		End-semester				
Evaluation by	***Institute***	***Industry***	***Institute***	***Industry***	***External Examiner***		
Software Training & Project	50	25	50	25	200	500	16
Industrial Training & Project	50	25	50	25			
Total	**300**				**200**	**500**	**16**

OR

Semester VII/VIII [Fourth year]						**Branch: Electrical & Electronics Engineering**			
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEEE-801-18/ BTELE-801-18	Optical Fibers and Communication	3	0	0	3	40	60	100	3
2	BTEEE-802-18/ BTEE-701C-18	Power Quality and FACTS	3	1	0	4	40	60	100	4
3	BTEEE-803-18/ BTELE-803-18	Microwave Engineering	3	0	0	3	40	60	100	3
4	BTEEE-812-18/ BTELE-812-18	Technical Report Writing and Presentation	0	0	8	8	60	40	100	4
5	BTEEE-820-18/ BTELE-820-18	Optical Fibers and Communication lab	0	0	4	4	30	20	50	2
6	BMPD-801-18	Mentoring and Professional Development of Students	0	1	0	1	50	-	50	S/US
Total			**9**	**2**	**12**	**23**	**260**	**240**	**500**	**16**

Or

Students may obtain relevant credits through MOOCS/SWAYAM Courses

PROFESSIONAL CORE COURSES [ELECTRICAL & ELECTRONICS ENGINEERING] (also Core Courses for Minor Degree of B. Tech. (Electrical & Electronics Engineering)										
Sem.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
Odd	BTEEE-301-18/ BTEE-301-18	Electrical Circuit Analysis	3	1	0	4	40	60	100	4
Odd	BTEEE-302-18/ BTEE-302-18	Analog Electronics	3	0	0	3	40	60	100	3
Odd	BTEEE-311-18/ BTEE-311-18	Analog Electronics Laboratory	0	0	2	2	30	20	50	1
Odd	BTEEE-303-18/ BTEE-303-18	Electrical Machines – I	3	0	0	3	40	60	100	3
Odd	BTEEE-312-18/ BTEE-312-18	Electrical Machines – I Laboratory	0	0	2	2	30	20	50	1
Odd	BTEEE-304-18/ BTEE-304-18	Electromagnetic Fields	3	1	0	4	40	60	100	4
Even	BTEEE-401-18/ BTEE-401-18	Digital Electronics	3	0	0	3	40	60	100	3
Even	BTEEE-412-18/ BTEE-412-18	Digital Electronics Laboratory	0	0	2	2	30	20	50	1
Even	BTEEE-402-18/ BTEE-402-18	Electrical Machines – II	3	0	0	3	40	60	100	3
Even	BTEEE-413-18/ BTEE-413-18	Electrical Machines – II Laboratory	0	0	2	2	30	20	50	1
Even	BTEEE-403-18/ BTEE-403-18	Power Electronics	3	0	0	3	40	60	100	3
Even	BTEEE-414-18/ BTEE-414-18	Power Electronics Laboratory	0	0	2	2	30	20	50	1

Even	BTEEE-404-18/ BTEE-404-18	Signals and Systems	3	0	0	3	40	60	100	3
Even	BTEEE-411-18/ BTEE-411-18	Measurements and Instrumentation Lab.	2	0	2	4	30	20	50	3
Odd	BTEE-501-18	Power Systems – I (Apparatus & Modelling)	3	1	0	4	40	60	100	3
Odd	BTEE-511-18	Power Systems-I Laboratory	0	0	2	2	30	20	50	1
Odd	BTEE-502-18	Control Systems	3	1	0	4	40	60	100	4
Odd	BTEE-512-18	Control Systems Laboratory	0	0	2	2	30	20	50	1
Odd	BTEE-503-18	Microprocessors	3	1	0	4	40	60	100	4
Odd	BTEE-513-18	Microprocessors Laboratory	0	0	2	2	30	20	50	1
Even	BTEE-601-18	Power Systems – II (Switchgear and Protection)	3	1	0	4	40	60	100	4
Even	BTELE-602-18	Digital Signal Processing	3	1	0	3	40	60	100	4
Even	BTEE-611-18	Electronic Design Laboratory	1	0	4	5	30	20	50	3
Even	BTEE-612-18	Power Systems-III Laboratory	0	0	2	2	30	20	50	1

PROFESSIONAL ELECTIVE (PE) COURSES [Electrical & Electronics Engineering] (also Professional Elective Courses for Minor Degree of B. Tech. (Electrical & Electronics Engineering)						
Sr. No.	**Semester**	**Programme Elective**	**Course Code**	**Course Title**	**Hrs/week**	**Credits**
1.	V (odd)	PE-1	BTEE-504A-18	Electrical Engineering Materials	3L:0T:0P	3
2.	V (odd)	PE-1	BTEE-504B-18	Switchgear and Protection	3L:0T:0P	3
3.	V (odd)	PE-1	BTEE-504C-18	Electrical Machine Design	**3L:0T:0P**	3
4.	V (odd)	PE-1	**BTEEE-504D-18**	**Computer Architecture**	**3L:0T:0P**	3
5.	VI (even)	PE-2	BTEE-603A-18	Electromagnetic Waves	3L:0T:0P	3
6.	VI (even)	PE-2	BTEE-603B-18	Power System Dynamics and Control	3L:0T:0P	3
7.	VI (even)	PE-2	BTEE-603C-18	Electrical Drives	3L:0T:0P	3
8.	VI (even)	PE-2	**BTEEE-603D-18**	**Digital Control Systems**	3L:0T:0P	3
9.	VI (even)	PE-3	BTEE-604A-18	High Voltage Engineering	3L:0T:0P	3
10.	VI (even)	PE-3	BTEE-604B-18	Power System Reliability	3L:0T:0P	3
11.	VI (even)	PE-3	BTEE-604C-18	Line-Commutated and Active PWM Rectifiers	3L:0T:0P	3
12.	VI (even)	PE-3	**BTEEE-604D-18**	**Embedded Systems**	3L:0T:0P	3
13.	VII/VIII (Odd/Even)	PE-4	BTEE-701A-18	Electrical Energy Conservation & Auditing	3L:0T:0P	3
14.	VII/VIII (Odd/Even)	PE-4	BTEE-701B-18	Computer Aided Power System Analysis	3L:0T:0P	3
15.	VII/VIII (Odd/Even)	PE-4	BTEE-701C-18	Power Quality and FACTS	3L:0T:0P	3
16.	VII/VIII (Odd/Even)	PE-4	**BTEEE-701D-18**	**Microcontroller and PLC**	3L:0T:0P	3
17.	VII/VIII (Odd/Even)	PE-5	BTEE-702A-18	Computational Electromagnetics	3L:0T:0P	3
18.	VII/VIII (Odd/Even)	PE-5	BTEEE-702B-18	High Voltage DC Transmission Systems	3L:0T:0P	3
19.	VII/VIII (Odd/Even)	PE-5	BTEE-702C-18	Control Systems Design	3L:0T:0P	3
20.	VII/VIII (Odd/Even)	PE-6	**BTEEE-702D-18**	**Optimization Techniques**	3L:0T:0P	3

21.	VII/VIII (Odd/Even)	PE-6	BTEE-703A-18	Industrial Electrical Systems	3L:0T:0P	3
22.	VII/VIII (Odd/Even)	PE-6	BTEE-703B-18	Restructured Power Systems	3L:0T:0P	3
23.	VII/VIII (Odd/Even)	PE-6	BTEE-703C-18	Advanced Electric Drives	3L:0T:0P	3
24.	VII/VIII (Odd/Even)	PE-6	**BTEEE-703D-18**	**Transducers and its Applications**	3L:0T:0P	3

The institute may offer Professional Elective (PE) Courses [Electronics and Electrical Engineering] as per the groups given below (PE in the list if AICTE curriculum)

		Group: A	Group: B	Group: C	Group: D
V (Odd)	**PE-1**	Electrical Engineering Materials	Switchgear and Protection	Electrical Machine Design	Computer Architecture
VI (even)	**PE-2**	Electromagnetic Waves	Power System Dynamics and Control	Electrical Drives	Digital Control Systems
	PE-3	High Voltage Engineering	Power System Reliability	Line-Commutated and Active PWM Rectifiers	Embedded Systems
VII /VIII(Odd/Even)	**PE-4**	Electrical Energy Conservation & Auditing	Computer Aided Power System Analysis	Power Quality and FACTS	Microcontroller and PLC
	PE-5	Computational Electromagnetics	High Voltage DC Transmission Systems	Control Systems Design	Optimization Techniques
	PE-6	Industrial Electrical Systems	Restructured Power Systems	Advanced Electric Drives	Transducers and its Applications

LIST OF OPEN ELECTIVE COURSES FOR STUDENTS OF OTHER PROGRAMMS OFFERED BY ELECTRICAL & ELECTRONICS ENGINEERING

Prerequisite: To have passed Basic Electrical Engineering/Basic Electronics Engineering Course

Sr. No.	Course Code	Semester	Course Title	L	T	P	Hours/ Week	Credits
1.	OEEE-101-18	Odd	Fundamentals in Control systems	3	0	0	3	3
2.	OEE-102-18	Odd-	Power Electronics	3	0	0	3	3
3.	OEEE-103-18	Odd	Energy Management	3	0	0	3	3
4.	OEE-104-18	Odd	Renewable Energy Sources	3	0	0	3	3
5.	OEEE-201-18	Even	Electric Drives	3	0	0	3	3
6.	OEE-201-18	Even	Electric Machines	3	0	0	3	3
7.	OEEE-202-18	Even	Materials in Electrical Systems	3	0	0	3	3
8.	OEEE-203-18	Even	Electric Safety	3	0	0	3	3

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Semester
1	BTHU-101-18	English	2:0:0	2	I/II
2	BTHU-102-18	English Laboratory	0:0:2	1	I/II
3	HSMC-XXX-18	To be selected by Individual Institutions from the given list of Humanities & Social Sciences including Management	3:0:0	3	VI
4	HSMC-XXX-18		3:0:0	3	VII
Total			-	9	-

List of Humanities & Social Sciences including Management

Sr. No.	Course Code	Course Title	Hours/ week	Credits
1.	HSMC103-18	Education, Technology and Society	2L:1T:0P	3
2.	HSMC104-18	History of Science and Technology in India	2L:1T:0P	3
3.	HSMC113-18	Values and Ethics	2L:1T:0P	3
4.	HSMC118-18	Introduction to Women's and Gender Studies	2L:1T:0P	3
5.	HSMC124-18	Sanskrit Bhasa	2L:1T:0P	3
6.	HSMC (MME-303)	Law and Engineering	2L:1T:0P	3

Details of Credits and Maximum Marks

Semester	Hrs per week	Credits	Maximum Marks
1&2	24+29	17.5+20.5=38	500+650=1150
3	26	20	750
4	30	22	850
5	24	18	750
6	32	26	850
7	31	24	850
8	23 (for those not opting for one semester training)	16	500
Total		**164**	**5700**

IKG Punjab Technical University

Syllabus

(3^{th} - 8^{th} Semester)

for

Undergraduate Degree Programme

Bachelor of Technology

in

ELECTRICAL & ELECTRONICS ENGINEERING

2018 & onwards

SEMESTER: III
[Second Year]

BTEEE-301-18/ BTEE-301-18	Electrical Circuit Analysis	3L:1T:0P	4 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Apply network theorems for the analysis of electrical circuits.
CO 2	Obtain the transient and steady-state response of electrical circuits.
CO 3	Analyze circuits in the sinusoidal steady-state (single-phase and three-phase). Analyze two port circuit behavior.
CO 4	Synthesize networks and filters.

Module 1: Basic Network Analysis (14 Hours)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Module 2: Electrical circuit and steady state analysis (14 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot convention in coupled circuits, Ideal Transformer. Analysis of electrical circuits using Laplace Transform for standard inputs, transformed network with initial conditions. Frequency response (magnitude and phase plots), series and parallel resonances.

Module 3: Network functions and two port network (10 Hours)

Driving point impedance and admittance, natural response of a network, transfer impedance and admittance, concept of pole and zeros in a network function, Routh Hurwitz criterion of stability.

Two Port Networks: terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Module 4: Network Synthesis and Filters (10 Hours)

Network synthesis techniques for 2-terminal network, Foster and Cauer forms.

Filters: Classification of filters, characteristics impedance and propagation constant of pure reactive network, ladder network, T-section, π-section, terminating half section, pass bands and stop bands, Design of constant-K, m-derived filters.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

BTEEE- 302-18/ BTEE- 302-18	**Analog Electronics**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Understand the characteristics of transistors.
CO 2	Design and analyse various rectifier and amplifier circuits.
CO 3	Design sinusoidal and non-sinusoidal oscillators.
CO 4	Understand the functioning of OP-AMP and design OP-AMP based circuits.

Module 1: Diode and BJT circuits (12 Hours)

P-N junction diode, *V-I* characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

BJT circuits: Structure and *V-I* characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers.

Module 2: MOSFET circuits (10 Hours)

MOSFET structure and *V-I* characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 3: Differential, multi-stage and operational amplifiers (10 Hours)

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 4: Linear applications of op-amp (10 Hours)

Idealized analysis of op-amp circuits. Specifications. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, voltage regulator, Oscillators: Principle of operation, Wein's bridge and phase shift oscillator.

Text/References:

1. A. S. Sedra & K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

BTEEE-303-18/ BTEE-303-18	Electrical Machines-I	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Understand the concepts of magnetic circuits.
CO 2	Understand the operation of DC machines.
CO 3	Analyse the differences in operation of different DC machine configurations.
CO 4	Analyse single phase and three phase transformers circuits.

Module 1: Magnetic fields and magnetic circuits (6 Hours)

Review of magnetic circuits - MMF, flux, reluctance, inductance; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

Module 2: DC machines (12 Hours)

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module 3: DC machine - motoring and generation (12 Hours)

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. *V-I* characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Module 4: Transformers (12 Hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency, Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses, Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.

2. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.
3. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
4. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

BTEEE-303-18/ BTEE-303-18	Electromagnetic Fields	3L:1T:0P	4 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

At the end of the course, students will demonstrate the ability:

CO 1	To understand the basic laws of electromagnetism.
CO 2	To obtain the electric and magnetic fields for simple configurations under static conditions.
CO 3	To analyse time varying electric and magnetic fields.
CO 4	To understand Maxwell's equation in different forms and different media.
CO 5	To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

Module 1: **Review of Vector Calculus (8 hours)**

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus- differentiation, partial differentiation, integration, vector operator, del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

Module 2: Static Electric Field (15 Hours)

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 3: Magnetic Forces, and Inductance (10 Hours)

Biot-Savart's law, Ampere's law of force, Ampere's circuital law, Faraday's law, Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic circuits, calculations of inductances and mutual inductances for a solenoid and toroid.

Module 4: Maxwell's Equations in Time Varying Fields and Wave theory (15 Hours)

Concept of displacement current and conduction current, Maxwell's equation-differential and integral form, Poynting's theorem, its significance and Poynting's vector, Boundary Conditions.

Wave theory: Derivation of wave equation, uniform plane waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Attenuation, phase and propagation constant, intrinsic impedance, Relation between E & H, wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect.

Text / References:

1. M. N. O. Sadiku, “Elements of Electromagnetics”, Oxford University Publication, 2014.
2. A. Pramanik, “Electromagnetism - Theory and applications”, PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, “Electromagnetism-Problems with solution”, Prentice Hall India, 2012.
4. G. W. Carter, “The electromagnetic field in its engineering aspects”, Longmans, 1954.
5. W. J. Duffin, “Electricity and Magnetism”, McGraw Hill Publication, 1980.
6. W. J. Duffin, “Advanced Electricity and Magnetism”, McGraw Hill, 1968.
7. E. G. Cullwick, “The Fundamentals of Electromagnetism”, Cambridge University Press, 1966.
8. B. D. Popovic, “Introductory Engineering Electromagnetics”, Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, “Engineering Electromagnetics”, McGraw Hill Education, 2012.

BTEE-305-18	Engineering Mechanics	3L:1T:0P	4 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO 1	Understand the concepts of co-ordinate systems.
CO 2	Analyse the three-dimensional motion.
CO 3	Understand the concepts of rigid bodies.
CO 4	Analyse the free-body diagrams of different arrangements.
CO 5	Analyse torsional motion and bending moment.

Module 1: Introduction to vectors and tensors and co-ordinate systems (5 hours)
Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.

Module 2: Three-dimensional Rotation (4 hours)
Three-dimensional rotation: Euler’s theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module 3: Kinematics of Rigid Body (6 hours)
Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between twoand three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies (5 hours)
Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler’s laws of rigid body motion.

Module 5: Free Body Diagram (1 hour)
Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (9 hours)
Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment (5 hours)
Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module 8: Torsional Motion (2 hours)
Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module 9: Friction (3 hours)
Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Text / References:

1. J. L. Meriam and L. G. Kraige, “Engineering Mechanics: Dynamics”, Wiley, 2011.
2. M. F. Beatty, “Principles of Engineering Mechanics”, Springer Science & Business Media,1986.

BTEEE-311-18/ BTEE-311-18	**Analog Electronics Laboratory**	**0L:0T:2P**	**1 Credit**

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO 1	Understand the use and importance of various types of equipment used in the laboratory.
CO 2	Ability to make circuits on bread-board.
CO 3	Analyze, take measurements to understand circuit behavior and performance under different conditions.
CO 4	Troubleshoot, design and create electronic circuits meant for different applications.
CO 5	Evaluate the performance electronic circuits and working small projects employing semiconductor devices.

Hands-on experiments related to the course contents of BTEEE302-18

Note: A student to perform any 8-10 experiments and make one minor working model project.

Suggested List of Experiments:

1. To draw *V-I* characteristics of a PN junction diode (Ge, Si, switching and signal).
2. To design half wave rectifier.
3. To design full wave and bridge rectifiers.
4. To study the transistor characteristics in common base, common collector, and common emitter configurations.
5. To study the *V-I* characteristics of a MOSFET.
6. To design a voltage regulator IC using zener diode and also see the effect of line and load regulation
7. To design various clippers and clampers using diodes.
8. To obtain the frequency response of an amplifier and calculate the gain bandwidth of the amplifier.
9. To investigate the emitter follower (Buffer) amplifier and determine A_V,R_i, and R_O
10. To design and study various type of oscillators, and determine frequency of oscillations.
11. To design a transistor series voltage regulator with current limits and observe its current feedback characteristics.
12. To study the characteristics of a complementary symmetry amplifier.
13. To study the application of an Op-Amp (741) as inverting and non-inverting amplifier.
14. To use the OP-AMP as summing, scaling and averaging amplifier.
15. Design differentiator and integrator using OP-AMP and also determine the time constant and cut-off frequency.

BTEEE-312-18/ BTEE-312-18	**Electrical Machines – I Laboratory**	**0L:0T:2P**	**1 Credit**

Internal Marks: 30 External Marks: 20 Total Marks: 50

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

CO 1	Analyze three-phase transformer/system connections.
CO 2	Evaluation of equivalent circuit parameters, efficiency and voltage regulation by performing various tests on transformer.
CO 3	Analyze parallel operation of transformers.
CO 4	Analyze performance characteristics of DC generators.

Hands-on experiments related to the course contents of BTEEE312-18

Note: A student to perform any 8-10 Experiments and make one minor working model project.

Suggested List of Experiments:

1. To perform the load test on a single phase transformer.
2. To perform open circuit and short circuit tests on a single phase transformer and hence draw the equivalent circuit, calculate the voltage regulation and efficiency.
3. To find the efficiency and voltage regulation of single phase transformer under different loading conditions.
4. To perform parallel operation of two single phase transformers.
5. To study the various connections of a three phase transformer.
6. To perform Scott connections on three phase transformer to get two phase supply.
7. To study the constructional details of DC machine and to draw sketches of different components.
8. To measure armature and field resistance of DC shunt generator and to obtain its open circuit characteristics.
9. To obtain load characteristics of DC shunt/series/compound generator.
10. To draw speed-torque and torque-speed characteristics of DC shunt/series /compound generator.
11. To study the three point and four point DC motor starters.
12. To perform Swinburne's test (no load test) to determine various losses of DC shunt motor.
13. To visualize the magnetic fields produced by a bar magnet and a current carrying coil using FEMM/ ANSYS Maxwell.
14. To visualize the magnetic field produced in an electrical machine using FEMM/ ANSYS Maxwell.

SEMESTER: IV [Second Year]

BTEEE-401-18/ BTEE-401-18	Digital Electronics	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO 1	Understand working of logic families and logic gates.
CO 2	Design and implement Combinational and Sequential logic circuits.
CO 3	Understand the process of Analog to Digital conversion and Digital to Analog conversion.
CO 4	Be able to understand memories.

Module 1: Fundamentals of Digital Systems and logic families (10 Hours)
Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Module 2: Combinational Digital Circuits (10 Hours)
Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Module 3: Sequential circuits and systems (12 Hours)
A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K-T and D- types flipflops, applications of flipflops, shift registers, applications of shift registers, serial o parallel converter, parallel to serial converter, ring counter, sequence generator, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Module 4: A/D and D/A Converters (10 Hours)
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit ,analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using Voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs, concept of memories.

Text/References:
1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

BTEEE-402-18/ BTEE-402-18	Electrical Machines – II	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Understand the concepts of rotating magnetic fields.
CO 2	Understand the operation of AC machines.
CO 3	Analyse performance characteristics of AC machines.
CO4	To understand the difference between the synchronous machines and asynchronous machines

Module 1: Fundamentals of AC machine windings (8 Hours)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Module 2: Pulsating and revolving magnetic fields (12 Hours)

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module 3: Induction Machines (12 Hours)

Concept of rotating magnetic field, Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and maximum torque, power flow diagram, Equivalent circuit. Phasor diagram, Losses and efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-fed induction machines.

Single phase induction motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Module 4: Synchronous machines (10 Hours)

Constructional features, cylindrical rotor and salient pole synchronous machine - generated EMF, coil span and distribution factor, equivalent circuit and phasor diagram, armature reaction at different power factor loads, voltage regulation by synchronous impedance and zero power factor method, concept of short circuit ratio, Operating characteristics of synchronous machines, V-curves and inverter-V curves. Hunting. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

BTEEE-403-18/ BTEE-403-18	**Power Electronics**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Understand the differences between signal level and power level devices.
CO 2	Analyse controlled rectifier circuits.
CO 3	Analyse the operation of DC-DC choppers.
CO 4	Analyse the operation of voltage source inverters.

Module 1: Power switching devices (8 Hours)

Diode, Thyristor, MOSFET, IGBT: *V-I* characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (10 Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC buck converter (12 Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage. DC-DC boost converter: Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module 4: Single-phase voltage source inverter (12 Hours)

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage. Three-phase voltage source inverter: Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
4. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

BTEEE-404-18/ BTEE-404-18	Signals and Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO 1	Understand the concepts of continuous time and discrete time systems.
CO 2	Analyse systems in complex frequency domain.
CO 3	Understand sampling theorem and its implications.
CO 4	Understand mathematical tools to be able to apply in state variable modeling

Module 1: Introduction to Signals and Systems (12 hours):

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module 2: Behavior of continuous and discrete-time LTI systems (12 hours)

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module 3: Fourier, Laplace and z- Transforms (10 hours)

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4: Sampling and Reconstruction (8 hours)

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. V. Oppenheim, A.S. Willsky & S.H. Nawab, “Signals and systems”, Prentice Hall, 1997.
2. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
3. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall,2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

BTAM 302-18	Mathematics-III (Probability and Statistics)	L-3, T-1,P-0	4 Credits
Internal Marks: 40 External Marks: 60 Total Marks: 100			
Pre-requisite: None			
Course Objectives: The objective of this course is to familiarize the student with statistical techniques. It aims to equip he students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.			
Course Outcomes: At the end of the course, the student will be able to			

CO1	Have basics knowledge about measure of central tendency, skewness, kurtosis and moments and their applications in engineering fields.
CO2	Familiarize the student with expectations of discrete and continuous random variable.
CO3	Familiarize probability techniques and random variables and detailed knowledge of probability distribution with so as to use it with any date of engineering problem formulation.
CO4	Have basic idea about statistics including correlation, regression and then up to advanced level with testing of large samples that is important in solving problems related to engineering.
CO5	To fit the given data into curves by various methods which forms an important application in engineering .

Section A **(22 lectures)**

Unit I

Measures of Central tendency: Moments, skewness and Kurtosis, Variance, Probability, conditional probability, Discrete and Continuous random variables, Expectations of Discrete and Continuous random variables.

Unit II

Probability distributions: Binomial, Poisson and normal , Poisson approximation to the binomial distribution, evaluation of statistical parameters for these three distribution, Bivariate distributions and their properties.

Section B **(20 lectures)**

Unit III

Correlation and regression for bivariate data, Rank correlation, Curve fitting by the method of least square, fitting of straight lines , second degree parabolas and more general curve.

Unit IV

Test of significances: Sampling and standard error, Tests of significance for large samples and small samples (t-distribution, F-distribution), Chi-square test for goodness of fit and independence of attributes.

Suggestion Text/Reference Books

1. S.P. Gupta, Statistical Methods, Sultan Chand & Sons, 33^{rd} Edition, 2005.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & sons, 2014.
3. S. Ross, A First Course in Probability, 6^{th} Edition, Pearons Education India, 2002.
4. N.P Bali and Mukesh Goyal, A text book of Engineering Mathematics , Laxmi Publications, Reprint, 2010.
5. Robert V. Hogg, Joseph W. Mekean and Allen T. Craig, Introduction to Mathematics Statistics,7^{th} Edition, Pearsons, 2012.

BTEEE-411-18/ BTEE-411-18	**Measurements and Instrumentation Laboratory**	**2L:0T:2P**	**3 credits**

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO 1	Design and validate DC and AC bridges.
CO 2	Analyze the dynamic response and the calibration of few instruments.
CO 3	Learn about various measurement devices, their characteristics, their operation and their limitations.
CO 4	Understand statistical data analysis.
CO 5	Understand computerized data acquisition.

Lectures/Demonstrations:

1. Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
2. Errors in Measurements. Basic statistical analysis applied to measurements: Mean, Standard Deviation, Six-sigma estimation, C_p, C_{pk}.
3. Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
4. Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.
5. Measurements of R, L and C.
6. Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
7. Digital Storage Oscilloscope.

Experiments

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of Low Resistance using Kelvin's double bridge.
5. Measurement of High resistance and Insulation resistance using Megger.
6. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
7. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
8. Usage of DSO to capture transients like a step change in R-L-C circuit.
9. Current Measurement using Shunt, CT, and Hall Sensor.
10. Measurement of frequency using Wein's Bridge.
11. To find 'Q' of an inductance coil and verify its value using Q- meter.
12. Plotting of Hysteresis loop for a magnetic material using flux meter.

Note: A student to perform any 8-10 Experiments and make one minor working model project.

BTEEE-412-18/ BTEE-412-18	Digital Electronics Laboratory	0L:0T:2P	1 Credit

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO 1	To understand of basic electronic components and circuits
CO 2	Understanding verify truth tables of TTL gates
CO 3	Design and fabrication and realization of all gates and basic circuits
CO 4	Design the truth tables and basic circuits
CO 5	Testing of basic electronics circuits

Hands-on experiments related to the course contents of BTEEE401-18

Note: A student to perform any 8-10 Experiments and make one working minor project.

Suggested List of Experiments:

1. Design a delay circuit using 555 timer and study the monostable, bistable and astable operations using 555.
2. a) Verification of the truth tables of TTL gates viz; 7400,7402, 7404, 7408,7432,7486.
   b) Design and fabrication and realization of all gates using NAND/NOR gates.
3. Verification of truth table of Mutiplexer(74150)/Demultiplexer(74154)
4. Design and verification of truth tables of half-adder, full-adder and subtractor circuits using gates 7483 and 7486(controlled inverter).
5. To study the operation of Arithmetic Logic Unit IC 74181.
6. Design fabrication and testing of
   a) Monostable multivibrator of t = 0.1ms approx. using 74121/123.testing for both positive and negative edge triggering, variation in pulse width and retriggering.
   b) Free running mutivibrator at 1KHz and 1Hz using 555 with 50% duty cycle. Verify the timing from theoretical calculations.
7. Design and test S-R flip-flop using NOR/NAND gates.
8. Design, fabricate and test a switch debouncer using 7400.
9. Verify the truth table of a JK flip flop using IC 7476,
10. Verify the truth table of a D flip flop using IC 7474 and study its operation in the toggle and asynchronous mode.
11. Operate the counters 7490, 7493 and 74193(Up/Down counting mode). Verify the frequency division at each stage. Using a frequency clock (say 1 Hz) display the count of LED's.
12. Verify the truth table of decoder driver7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock. Repeat the above with the BCD to Decimal decoder 7442.

BTEEE-413-18/ BTEE-413-18	Electrical Machines-II Laboratory	0L:0T:2P	1 Credit

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO 1	Construct equivalent circuits induction motors by routine tests.
CO 2	Comprehend the requirement of starting and speed control methods of induction motors in the various applications of industry.
CO 3	Construct equivalent circuits of synchronous generator and motor.
CO 4	Apply knowledge to show utility of alternator, synchronous motors and synchronous condenser for various applications in power system.
CO 5	Construct characteristic curves for induction and synchronous machines
CO 6	Understand the concept of parallel operation of three phase alternators.

Hands-on experiments related to the course contents of BTEEE402-18

Note: A student to perform any 8-10 Experiments and make one hardware/software based minor project.

Suggested List of Experiments:

1. To perform load-test on three-phase Induction motor and to plot torque versus speed characteristics.
   a) To perform no-load and blocked–rotor tests on three-phase Induction motor to obtain equivalent circuit.
   b) To develop an algorithm (Matlab/C/C++) for speed torque characteristics using calculated equivalent circuit parameters.
2. To study the speed control of three-phase Induction motor by Kramer's Concept.
3. To study the speed control of three-phase Induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor.
4. To study star- delta starters physically and
   a) to draw electrical connection diagram
   b) to start the three-phase Induction motor using it.
   c) to reverse the direction of three-phase Induction motor
5. To start a three-phase slip –ring induction motor by inserting different levels of resistance in the rotor circuit and plot torque –speed characteristics.
6. To perform no-load and blocked–rotor test on single-phase Induction motor and to determine the parameters of equivalent circuit drawn on the basis of double revolving field theory.
7. To perform no load and short circuit. Test on three-phase alternator and draw open and short circuit characteristics.
8. To find voltage regulation of an alternator by zero power factor (ZPF.) method.
9. To study effect of variation of field current upon the stator current and power factor with synchronous motor running at no load and draw Voltage and inverted Voltage curves of motor.
10. Parallel operation of three phase alternators using
    (i) Dark lamp method (ii) Two-Bright and one dark lamp method
11. To study synchroscope physically and parallel operation of three-phase alternators using synchroscope.
12. Starting of synchronous motors using:
    (i) Auxiliary motor (ii) Using Damper windings

BTEEE-414-18/ BTEE-414-18	**Power Electronics Laboratory**	**0L:0T:2P**	**1 Credit**

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO 1	Understand the properties and characteristics of thyristors.
CO 2	Understand the different types of waveforms of inverter and chopper circuits.
CO 3	Analyze speed and direction control of single phase and three phase electric motors using ac and dc drive.
CO 4	Understand the effect of free-wheeling diode on pf with RL load.
CO 5	Check the performance of a choppers, and inverter.

Hands-on experiments related to the course contents of BTEEE403-18

Note: A student to perform any 8-10 Experiments and make one hardware/software based minor project.

Suggested List of Experiments:

1. To plot V-I characteristics and study the effect of gate triggering on turning on of SCR.
2. To study the effect of free-wheeling diode on power factor for single phase half-wave rectifier with R-L load.
3. To plot waveforms for output voltage and current, for single phase full-wave, fully controlled bridge rectifier, for resistive and resistive cum inductive loads.
4. Study of the microprocessor-based firing control of a bridge converter.
5. To study three phase fully controlled bridge converter and plot waveforms of output voltage, for different firing angles.
6. To study Jones chopper or any chopper circuit to check the performance.
7. Thyristorised speed control of a D.C. Motor.
8. Speed Control of induction motor using thyristors.
9. Study of series inverter circuit and to check its performance.
10. Study of a single-phase cycloconverter.
11. To check the performance of a McMurray half-bridge inverter.

BTEEE-521-18	**Summer Industry Internship/ Field Training**	**(Non-Credit)**

Six weeks in an Industry in the area of Electronics and Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. The student will make a presentation based upon the Industry Internship attended. Performance to be rated as Satisfactory/Un -Satisfactory (S/US). For unsatisfactory the internship to be repeated.

Evaluation scheme (Summer Industry Internship/ Field Training)

Internal ***(to be evaluated by Industry)***	***Marks***	***External**** ***(to be evaluated by Department)***	***Marks***
Attendance	15	Daily Dairy	5
Performance (Work done /simulation/hardware/project developed)	30	Report	10
Report	10	Presentation (Work done /simulation/hardware/project developed)	25
Daily Dairy	05		
Total	***60***	***Total***	***40***

*External examiner not to be called.

Mandatory Courses (non-credit)

BTMC-101-18	Indian Constitution	3L:0T:0P	0 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does nottruly incorporate our own

ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1 Meaning of the constitution law and constitutionalism
2 Historical perspective of the Constitution of India
3 Salient features and characteristics of the Constitution of India
4 Scheme of the fundamental rights
5 The scheme of the Fundamental Duties and its legal status
6 TheDirectivePrinciplesofStatePolicy–Itsimportanceandimplementation
7 Federal structure and distribution of legislative and financial powers between the Union and the States
8 Parliamentary Form of Government in India – The constitution powers and status of the President of India
9 Amendment of the Constitutional Powers and Procedure
10 The historical perspectives of the constitutional amendments in India
11 Emergency Provisions : National Emergency, President Rule, Financial Emergency

12 Local Self Government – Constitutional Scheme in India
13 Scheme of the Fundamental Right to Equality
14 Scheme of the Fundamental Right to certain Freedom under Article19
15 ScopeoftheRighttoLifeandPersonalLibertyunderArticle21

Objectives: The objective of the course is to provide the basic knowledge about the Political System of the Country. The basic idea is to make the students aware of their duties and rights. Apart from it the course will aim to educate the pupils about the working of different organs of the government, various constitutional bodies and the agencies of the government. In addition to it, students will be given brief knowledge regarding the different challenges of Indian Political System, forms of Government in India and nature & dimensions of Indian Federal System.

Course Pedagogy: Since the course is of Practical Importance, it is recommended that during the course students will be taken out for one visit to any place with the potential of imparting practical knowledge to the students about the Indian Political System. Such places can be Indian Parliament. State Legislative Assembly, Youth Parliament Pune. It is expected that students should be given case studies about the Indian Political System and Debates on Constitutional Issues should be organised in the campus.

Course Outcome: After the successful completion of the course students will be to understand the different dimensions of Indian Political System. They will be aware about their duties towards the fellow citizens. Students will be able to challenges of the democratic institutions and theoretical aspects of the state and its organs.

Suggested Reading:

1. Indian Political System by J C Johri
2. Indian Political System by Mahendra Prasad Singh
3. Fundamentals of Indian Political System by Rajesh K Jha
4. Our Constitution by Subhash C Kashyap
5. Our Political System by Subhash C Kashyap
6. Indian Federalism – An Introduction by Mahendra Prasad Singh
7. Indian Federalism and Autonomy by S Chandrasekhar

BTMC-102-18	Essence of Indian Traditional Knowledge	3L:0T:0P	0 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Part-1

Course objective

The course aims at imparting basis principals of thought process. Reasoning and inferencing Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit Literature are also important in modern society with rapid technological advancements and societal disruptions Part-1 focuses on introduction to Indian Knowledge System. Indian perspective of modern scientific world -view and basis principal of Yoga and holistic health care system.

Course contents

i. Basic Structure of Indian Knowledge system
ii. Modern Science and Indian Knowledge system
iii. Yoga and Holistic Health Care
iv. Case studies

References

- Fritzof Capra Too of Physics
- Fritzof Capra The Wave of life
- Yoga Sutra of Patanjali. Ramakrishna Mission. Kolkata.
- RN Jha Science of Consciousness Psychotherapy and Yoga Practices. Vidyanidhi Prakashan. Delhi2016
- PB Sharma (English translation) ShodashangHridayam

Pedagogy: Problem based learning, group discussion, collaborative mini projects
Outcome: Ability to understand connect up and explain basics of Indian traditional Knowledge in Modern scientific perspective.

Part-2

Course objective

The course aims at imparting basis principals of thought process. Reasoning and inferencing Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit Literature are also important in modern society with rapid technological advancements and societal disruptions Part-2 focuses on Indian philosophical traditions. Indian linguistic Tradition, and Indian artistic tradition.

Course contents

i. Philosophical Tradition
ii. Indian Linguistic Tradition (Phonology, morphology, syntax and semantics)
iii. Indian Artistic Tradition
iv. Case studies

References

- V.Sivaramakrishnan (Ed.), Cultural Heritage of India-Course material, Bhartiya Vaidya Bhawan Mumbai 5th Edition 2014
- S.C Chaterjee &D.M .Datta , An introduction to Indian Philosophy ,University of Calcutta 1984
- KS Subrahmanialyer ,Vakyapadiya of Bhattaraihari (Brahma Kanda), Deccan College Pune 1965

- VN Jha, Language Thought and Reality
- Pramod Chandra. India Arts Howard Univ. Press 1983
- Krishna Chaitanya Arts of India. Abhinav Publications. 1987
- R Nagaswamy , Foundations of Indian Art Tamil Arts Academy.2002

Pedagogy: Problem based learning, group discussion, collaborative mini projects
Outcome: Ability to understand connects up and explain basics of Indian traditional Knowledge in Modern scientific perspective.

SEMESTER: V [Third Year]

BTEE-501-18	**Power Systems-I (Apparatus and Modelling)**	**3L:1T:0P**	**Credits:4**

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:
At the end of this course, students will demonstrate the ability to:
CO 1 Understand the concepts of power systems.
CO 2 Understand the various power system components.
CO 3 Evaluate fault currents for different types of faults.
CO 4 Understand the generation of over-voltages and insulation coordination.
CO 5 Understand basic protection schemes.
CO 6 Understand concepts of HVDC power transmission and renewable energy generation.

Module 1: Basic Concepts (4 hours)
Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.
Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources.
Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.

Module 2: Power System Components (15 hours)
Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Travelling-wave Equations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power.
Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.

Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.

Module 3: Over-voltages and Insulation Requirements (4 hours)
Generation of Over-voltages: Lightning and Switching Surges. Protection against Over-voltages, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams.

Module 4: Fault Analysis and Protection Systems (10 hours)
Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding. Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Module 5: Introduction to DC Transmission & Renewable Energy Systems (9 hours)

DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC) based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. Solar PV systems: I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines.

Text/References:

1. J.S. Dhillon I.J. Nagrath and D.P. Kothari, Power System Engineering, 3rd Edition, McGraw Hill Education (India) Private Ltd., 2019
2. D.P. Kothari and J. S. Dhillon, Power System Optimization, 2nd edition, Prentice Hall of India Pvt. Ltd.,New Delhi, 2011, ISBN -978-81-203-4085-5.
3. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
4. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
5. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
6. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
7. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

BTEE-502-18	Control Systems	3L:1T:0P	4 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

CO 1 Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.

CO 2 Understand the concept of stability and its assessment for linear-time invariant systems. Design simple feedback controllers.

Module 1: Introduction to control problem (4 hours)

Industrial Control examples. Control hardware and their models. Transfer function models of linear time-invariant systems.

Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Module 2: Time Response Analysis (10 hours)

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.

Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Module 3: Frequency-response analysis (6 hours)

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module 4: Introduction to Controller Design (10 hours)

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems.

Root-loci method of feedback controller design.

Design specifications in frequency-domain. Frequency-domain methods of design.

Module 5: State variable Analysis (6 hours)

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability.

Pole-placement by state feedback.

Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Module 6: Introduction to Optimal Control and Nonlinear Control (5 hours) Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts.

Text/References:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.

BTEE-503-18	**Microprocessors**	**3L:1T:0P**	**4 credits**

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

CO 1 Study of 8085 and 8086 Microprocessors.
CO 2 Do assembly language programming.
CO 3 Do interfacing design of peripherals like 8255, 8253,8279,8251 etc.
CO 4 Develop systems using different microprocessors.

Module 1: Fundamentals of Microprocessors: (3 Hours)

Digital Computers: General architecture and brief description of elements, programming system, Buses and CPU Timings. Microprocessor and Microprocessor Development Systems: Evolution of Microprocessor, memory, data transfer schemes, architecture advancements of microprocessors, typical microprocessor development system, higher lever languages.

M**odule 2: The 8085 Architecture (10 Hours)**

Microprocessor architecture and its operations, Pin configuration, internal architecture. Timing & Signals: control and status, interrupt: ALU, machine cycles, Instruction format, op-codes, mnemonics, number. of bytes, Instruction Set of 8085: Addressing Modes: Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing. RTL, variants, number. of machine cycles and T states, addressing modes. Instruction Classification: Data transfer, arithmetic operations, logical operations, branching operation, machine control; Writing assembly Language programs, Assembler directives.

M**odule 3: The 8086 Architecture (9 Hours)**

8086 Microprocessors: Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes Instruction Set of 8086 Addressing Modes: Instruction format: Discussion on instruction Set: Groups: data transfer, arithmetic, logic string, branch control transfer, processor control. Interrupts: Hardware and software interrupts, responses and types.

Module4: Fundamental of Programming (9 Hours)

Development of algorithms, flowcharts in terms of structures ,(series, parallel, if-then-else etc.) Assembler Level Programming: memory space allocation (mother board and user program) Assembler level programs (ASMs) .

Module 5: Peripheral memory and I/O **Interfacing (9 Hours)**

Interfacing devices, Interfacing of Memory, Programmed I/O, Interrupt Driven I/O, memory I/O, 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller, 8251- USART

Text / References:

1. Gaonkar, Ramesh S, “Microprocessor Architecture, programming and applications with the 8085” Pen ram International Publishing 5th Ed.
2. Uffenbeck, John, “Microcomputers and Microprocessors” PHI/ 3rd Edition.
3. Ray, A.K. & Burchandi, K.M., “Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing” Tata Mc. Graw Hill.
4. Krishna Kant, “Microprocessors and Microcontrollers” PHI Learning.
5. Brey, Barry B. “INTEL Microprocessors” Prentice Hall (India)
6. ADitya P Mathur, “Introduction to Microprocessor” Tata Mc Graw Hill
7. M. Rafiquzzaman, “Microprocessors- Theory and applications” PHI

8. B. Ram, “Advanced Microprocessor & Interfacing” Tata McGraw Hill
9. Renu Singh & B.P.Singh, “Microprocessor and Interfacing and applications” New Age International 10. N. Senthil Kumar, “Microprocessors and Microcontroller”, Oxford University Press.
10. Liu and Gibson G.A., “Microcomputer Systems: The 8086/8088 Family” Prentice Hall (India)

Semester	Programme Elective	Course Code	Course Title	Hrs/week	Credits
V (odd)	PE-1	BTEE-504A-18	Electrical Engineering Materials	3L:0T:0P	3
V (odd)	PE-1	BTEE-504B-18	Switchgear and Protection	3L:0T:0P	3
V (odd)	PE-1	BTEE-504C-18	Electrical Machine Design	3L:0T:0P	3
V (odd)	PE-1	BTEEE-504D-18	Computer Architecture	3L:0T:0P	3

BTEE-504A-18	Electrical Engineering Materials	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

CO 1 To Understand the basic concepts of materials.
CO 2 To use simplified materials selection concepts for design purposes.
CO 3 To Understand the properties of Materials.

Module I: Elementary Materials Science Concepts (8 hours)
Bonding and types of solids, Crystalline state and their defects, Classical theory of electrical and thermal conduction in solids, temperature dependence of resistivity, skin effect, Hall effect.

Module II: Conductivity of Metal (8 hours)
Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects.

Module III: Magnetic properties of Materials (8 hours)
Introduction, Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

Module IV: Dielectric Properties (8 hours)
Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferroelectricity, piezoelectricity.

Module V: Semiconductors (8 hours)
Energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

Text Books:

1. Adrianus J Dekker Electrical Engineering Materials PHI Learning Publishers.
2. L. Solymar, Electrical Properties of Materials, 8th Edition by Oxford University Press New Delhi.
3. C Indulkar, Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by, S. Chand & Company Ltd-New Delhi.
4. SK Bhattacharya, Electrical and Electronic Engineering Materials, Khanna Publishers, New Delhi.

BTEE-504B-18	**Switchgear and Protection**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

CO 1 Understand power system protection.
CO 2 Understand the main components used in power system protection for electric machines, transformers.
CO 3 Understand the bus bars, overhead and underground feeders.
CO 4 Understand the earthing protection.

Module 1: Electrical Switchgear

Fundamentals and Types of Circuit Breakers, Gaseous Discharges and Ionization Process in a Gaseous Insulating Medium, decay Process, Quenching of AC Arc, Arc Interruption Theories, Fuse-types, Rating, Selection, theory and characteristics, application, Factors Affecting RRRV, Re-Striking Voltage and Recovery Voltage, Resistance Switching, Quenching of DC Arc, High-Voltage AC Circuit Breakers, High-Voltage DC (HVDC) Circuit Breakers, Isolators.

Module 2: Protective Relaying System

Basics terminology and operating principle of Relays, Functions of Protective Relay Schemes, Basic Tripping Circuit with System Transducers, Zones of Protection, Requirements of a Protective System, Relay Operating Criteria, Main and Back-Up Protection.

Relays: Introduction, classification, constructional features; and Characteristics of Electromagnetic, Induction, Thermal, Overcurrent relays, Directional relays, Distance relays, Differential, Negative sequence relay, introduction to static and up-based relays.

Static Relays: Introduction, Basic Elements & Classification of Static Relays, Advantages and limitations of Static Relays.

Module 3: Power Apparatus Protection

Generator Protection: Generators faults, Differential Protection, Inter-Turn Fault Protection, Stator Earth-Fault Protection, Rotor Earth-Fault Protection, Negative Phase Sequence Protection (Protection Against Unbalanced Loading), Field Failure Protection (Protection Against Loss of Excitation), Overload Protection, Overvoltage Protection, Reverse Power Protection, Under-Frequency Protection.

Transformer Protection: Faults in Transformers, Gas-Operated Relays, Overcurrent Protection, Restricted Earth-Fault Protection, Differential Protection, Protection Against Over fluxing, Protection of Grounding Transformers, Protection Against Overheating

Module 4: Protection of Feeders and Transmission line:

Protection of Feeders: Basic Radial Feeder, Methods of Discrimination, Time and current protection, different pilot wire protection of feeders, current balance differential protection, Differential and Distance protection of feeders, choice between Impedance, Reactance and Mho relays.

Protection of Transmission Lines: Overcurrent Relays, Rules for Setting the IDMT Relays, Distance Relays: Stepped Distance Characteristics of a Distance Relay, Elementary idea about carrier current protection of lines, Quantities to be Fed to Distance Relays

Module 5: Bus Zone, Over voltage and Earthing Protection:
Bus-zone protection: Introduction, Bus-bar arrangements, Bus-zones faults, Protection Requirements, Fault-bus and backup protection of bus-bars, Non-Unit Protection by Back-up Relays, Unit Protection Schemes.
Protection against over voltage and earthing: Ground wires, Rod gap, Impulse gap, Valve type and Metal Oxide Arresters, Line Arrester/Surge Absorber. Ungrounded neutral system, Grounded neutral system and Selection of Neutral Grounding.

Text Books

1. B. A. Oza, Nirmal Kumar, C. Nair, R. P. Mehta, V. H. Makwana, Power System Protection & Switchgear, 1st Edition, Mc Graw Hill
2. Badri Ram, D. N. Vishwakarma, Power System Protection and Switchgear, Mc Graw Hill
3. Power System Protection and Switchgear by Wiley, John Wiley & Sons Canada, Limited,
4. Sunil S. Rao, Switchgear and Protection, 8th Edition, Khanna Book Publications
5. Handbook on switchgears, Bharat Heavy Electrical Limited

BTEE-504C-18	Electrical Machine Design	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

i. Understand the construction and performance characteristics of electrical machines.
ii. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
iii. Understand the principles of electrical machine design and carry out a basic design of an ac machine.
iv. Use software tools to do design calculations.

Module 1: Introduction

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Module 2: Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Module 3: Induction Motors

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Module 4: Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Module 5: **Computer aided Design (CAD):**

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.

5. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
6. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft’s Maxwell 2D machine design package.

BTEEE-504D-18	Computer Architecture	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

CO 1 Understand the concepts of microprocessors, their principles and practices.

CO 2 Write efficient programs in assembly language of the 8086 family of microprocessors. Organize a modern computer system and be able to relate it to real examples.

CO 3 Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.

CO 4 Implement embedded applications using ATOM processor.

Module 1: Introduction to computer organization (6 hours)

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

Module 2: Memory organization (6 hours)

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

Module 3: Input – output Organization (8 hours)

Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

Module 4: 16 and 32 microprocessors (8 hours)

80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86

Module 5: Pipelining(8 hours)

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

Module 6: Different Architectures (8 hours)

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Refence Books

1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
4. W. Stallings, "Computer organization", PHI, 1987.

5. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.
6. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, "Microcomputer Systems: The 8086/8088 Family", Prentice Hall India, 1986.
8. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
9. B. Govindarajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
10. P. Able, "8086 Assembly Language Programming", Prentice Hall India.

EVS-101-18	**Environmental Studies**	**2L:0T:0P (Contact hours 21)**	**0 credits**

Internal Marks: 50 *External Marks: 00* *Total Marks: 50*

*** 40 Hours are kept for various activities under the head of activities. There will be a final theory examination for the students of 50 marks but these marks will not be added to their final result as assessment will be satisfactory or non-satisfactory.**

Course Outcomes:

CO 1 Students will enable to understand environmental problems at local and national level through literature and general awareness.

CO 2 The students will gain practical knowledge by visiting wildlife areas, environmental institutes and various personalities who have done practical work on various environmental Issues.

CO 3 The students will apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems.

CO 4 Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world

Environment Science (Mandatory non-credit course)

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students.

Detailed Contents

Module 1: Natural Resources : Renewable and non-renewable resources

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Module 2: Ecosystems

Concept of an ecosystem. Structure and function of an ecosystem.

Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of following ecosystems:

a) Forest ecosystem
b) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Module 3 : Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-sports of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India

Module 4 : Social Issues and the Environment

- From Unsustainable to Sustainable development
- Resettlement and rehabilitation of people; its problems and concerns.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion,
- Nuclear accidents and holocaust. Case Studies.
- Public awareness.

***ACTIVITIES**

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.

Following activities must be included.

Identify a tree fruit flower peculiar to a place or having origin from the place.

Making high resolution big photographs of small creatures (bees, spiders, ants. Mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).

Videography/ photography/ information collections on specialties/unique features of different types of common creatures.

Search and explore patents and rights related to animals, trees etc. Studying miracles of mechanisms of different body systems.

(A) Awareness Activities:

a) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
b) Slogan making event
c) Poster making event
d) Cycle rally
e) Lectures from experts
f) Plantation
g) Gifting a tree to see its full growth
h) Cleanliness drive

i) To live with some eminent environmentalist for a week or so to understand his work.
j) To work in kitchen garden for mess
k) To know about the different varieties of plants
l) Shutting down the fans and ACs of the campus for an hour or so
m) Visit to a local area to document environmental assets river/forest/grassland/hill/mountain/lake/Estuary/Wetlands
n) Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
o) Visit to a Wildlife sanctuary, National Park or Biosphere Reserve

Suggested Readings

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
8. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
9. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
11. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
12. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
13. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
14. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

BTEE-511-18	***Power Systems – I Laboratory***	**0L:0T:2P**	**1 credit**

Internal Marks: 30   External Marks: 20   Total Marks: 50

Hands-on experiments related to the course contents of BTEE501-18. Visits to power system installations (generation stations, EHV substations etc.) are Exposure to fault analysis and Electro-magnetic transient program (EMTP) and Numerical Relays are suggested.

Note: A student to perform any 8-10 Experiments.

Suggested List of Experiments:

(A) Hardware Based:

1. To measure negative sequence and zero sequence reactance of Synchronous Machines.
2. Fault analysis for line-to-line (L-L), Line-to-Ground (L-G) and double line to ground fault.
3. To study the performance of a transmission line and compute its ABCD parameters.
4. To study the earth resistance using three spikes.
5. To study the IDMT over current relay and determine the time current characteristics
6. To study percentage differential relay
7. To study Impedance, MHO and Reactance type distance relays.
8. To study operation of oil testing set.

(B) Simulation Based Experiments (using MATLAB or any other software)

9. To obtain steady state, transient and sub-transient short circuit currents in an alternator
10. To perform symmetrical fault analysis in a power system
11. To perform unsymmetrical fault analysis in a power system

BTEE-512-18	*Control Systems Laboratory*	0L:0T:2P	1 credit

Internal Marks: 30 *External Marks: 20* *Total Marks: 50*

Hands-on experiments related to the course contents of BTEE502-18

Note: A student to perform any 8-10 Experiments.

Suggested List of Experiments:

1. To study the characteristics of potentiometers and to use 2- potentiometers as an error detector in a control system.
2. To study the synchro Transmitter-Receiver set and to use it as an error detector
3. To study the Speed – Torque characteristics of an AC Servo Motor and to explore its applications.
4. To study the Speed – Torque characteristics of an DC Servo Motor and explore its applications.
5. To study the variations of time lag by changing the time constant using control engineering trainer
6. To simulate a third order differential equations using an analog computer and calculate time response specifications
7. To obtain the transfer function of a D.C. motor – D.C. Generator set using Transfer Function Trainer
8. To study the speed control of an A.C. Servo Motor using a closed loop and an open loop systems
    a) To study the operation of a position sensor and study the conversion of position in to corresponding voltage
    b) To study an PI control action and show its usefulness for minimizing steady state error of time response.
9. To measure Force / Displacement using Strain Gauge in a wheat stone bridge
10. To design a Lag compensator and test its performance characteristics.
11. To design a Lead-compensator and test its performance characteristics.
12. To design a Lead-Lag compensator and test its performance characteristics.

BTEE-513-18	Microprocessors Laboratory	0L:0T:2P	1 credit

Internal Marks: 30   *External Marks: 20*   *Total Marks: 50*

Hands-on experiments related to the course contents of BTEE503-18

Note: A student to perform any 8-10 Experiments.

Suggested List of Experiments:

1. To study 8085 based microprocessor system
2. To study 8086 and 8086A based microprocessor system
3. To study Pentium Processor
4. To develop and run a program for finding out the largest/smallest number from a given set of numbers.
5. To develop and run a program for arranging in ascending/descending order of a set of numbers
6. To perform multiplication/division of given numbers
7. To perform conversion of temperature from 0 F to 0 C and vice-versa
8. To perform computation of square root of a given number
9. To perform floating point mathematical operations (addition, subtraction, multiplication and division) 10. To obtain interfacing of RAM chip to 8085/8086 based system
10. To obtain interfacing of keyboard controller, 8279
11. To obtain interfacing of PPI, 8255
12. To obtain interfacing of USART, 8251
13. To perform microprocessor-based stepper motor operation through 8085 kit
14. To perform microprocessor-based traffic light control
15. To perform microprocessor-based temperature control of hot water.

BTEEE-521-18	Summer Industry Internship	(Non-Credit) S/US

Internal Marks: 40 *External Marks: 60*

Six weeks in an Industry in the area of Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. Performance to be rated as Satisfactory/Un - Satisfactory (S/US). For unsatisfactory the internship to be repeated.

BMPD-501-18	Mentoring and Professional Development of Students	0L:1T:0P	(Non-Credit)

Internal Marks: 50 *External Marks: 00*

The assigned mentor to engage the students to in activities such as:

i. Identification of any one of the local environmental concern and propose workable solution for it.
ii. Arrange an Industrial visit of 2-3 days
iii. Expert/Invited talk pertaining to recent industrial development.
iv. Preparation of database for placement activities.
v. Resume preparation.

The mentor to keep record of all activities (including those mentioned above) and assign internal marks accordingly.

Semester: VI [Third Year]

BTEE-601-18	Power Systems – II (Operation & Control)	3L:1T:0P	4 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

(i) Use numerical methods to analyze a power system in steady state.
(ii) Understand stability constraints in a synchronous grid.
(iii) Understand methods to control the voltage, frequency and power flow.
(iv) Understand the monitoring and control of a power system.
(v) Understand the basics of power system economics.

Module 1: Power Flow Analysis (8 hours)

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Module 2: Stability Constraints in synchronous grids (10 hours)

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation.

Module 3: Control of Frequency and Voltage (8 hours)

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Power flow control using embedded dc links, phase shifters.

Module 4: Monitoring and Control (8 hours)

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

Module 5: **Modern Power System Management (8 hours)**

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

Text/Reference Books:

1. J. Grainger and W. D. Stevenson, Power System Analysis, McGraw Hill Education, 1994.
2. O. I. Elgerd, Electric Energy Systems Theory, McGraw Hill Education, 1995.

3. A. R. Bergen and V. Vittal, Power System Analysis, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, Electric Power Systems, Wiley, 2012.

BTELE-602-18	Digital Signal Processing	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

- Acquire knowledge about the time domain representation and classification of discrete time signals and systems
- Acquire knowledge about the time domain analysis of linear time invariant discrete time systems and representation of total response in various formats
- Acquire knowledge about the application of discrete time Fourier transform, Discrete Fourier series and z-transform for discrete time signal representation and analysis of linear time invariant systems discrete time systems.
- Acquire knowledge about the application of discrete Fourier transform in signal representation and system analysis and DFT computation using FFT algorithms.

Module 1: Introduction and Discrete Time Signals and Systems (10)

Introduction: Signals, Systems and Signal processing, Classification of Signals, Concept of frequency in continuous time and discrete time signals.

Discrete Time Signals and Systems: Discrete time signals, Discrete time systems, Analysis of discrete time linear time-invariant systems, Discrete time systems described by difference equations, Implementation of discrete system, Correlation of discrete time signals.

Module 2: Z-Transform (8)

Z-transformation, properties of Z-transformation, Rational Z-transformation, Inversion of Z-transform, Analysis of linear time invariant systems in Z domain.

Module 3: Frequency Analysis of Signals and Systems (8)

Frequency analysis of continuous time signals, Frequency analysis of discrete time signals, Properties of Fourier Transform for discrete time signals, Frequency domain characteristics of linear time invariant systems, linear invariant systems as frequency selective filters, Inverse systems and de-convolution.

Module 4: The Discrete Fourier Transform (6)

Frequency domain sampling, Properties of Discrete Fourier Transform (DFT), Linear filtering methods based on DFT, Frequency analysis of signals using the DFT.

Module 5: Design of Digital Filters (10)

General considerations, Design of Finite Impulse Response (FIR) filters, Design of Infinite Impulse Response (IIR) filters from analog filters, Frequency transformations, Design of digital filters based on least-square method and window method, Comparison of IIR and FIR filters.

Text/References:

1. Oppenheim A.V. and Schafer, R.W., Digital Signal Processing, Prentice Hall (India)
2. Kuo, Sen-Maw and Gan, Woon-Seng, Digital Signal Processing architectures, Implementations, and Applications McGraw Hill
3. Proakais John G., Digital Signal Processing: Principles, Algorithms, and Applications, Pearson Education 4th Ed. (2007)
4. Richard G Lyons, Understanding Digital Signal Processing, Pearson Education Publications.
5. Mitra K. Sanjit, Digital Signal Processing, 3rd ed. Tata McGraw Hill
6. Hayes Mansen, Schaum's Outline of Digital Signal Processing, Tata MGraw Hill, (2001)

BTEE-611-18	Electronics Design Laboratory	1L:0T:2P	2 credits

Internal Marks: 30 *External Marks: 20* *Total Marks: 50*

Course Outcomes:

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

(i) Understand the practical issues related to practical implementation of applications using electronic circuits.

(ii) Choose appropriate components, software and hardware platforms.

(iii) Design a Printed Circuit Board, get it made and populate/solder it with components.

(iv) Work as a team with other students to implement an application.

Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, Complex Programmable Logic Devices (CPLDs), and field-programmable gate arrays (FPGAs), and printed circuit boards (PCB) design and layout; System assembly considerations. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Text/Reference Books

1. S. Sedra and K. C. Smith, “Microelectronic circuits”, Oxford University Press, 2007.
2. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1997.
3. H.W.Ott, “Noise Reduction Techniques in Electronic Systems”, Wiley, 1989.
4. W.C. Bosshart, “Printed Circuit Boards: Design and Technology”, Tata McGraw Hill, 1983.
5. G.L. Ginsberg, “Printed Circuit Design”, McGraw Hill, 1991.

BTEE-612-18	***Power Systems-II Laboratory***	**0L:0T:2P**	**1 credit**

Internal Marks: 30 External Marks: 20 Total Marks: 50

Hands-on and computational experiments related to the course contents of BTEE-601-18. This should include programming of numerical methods for solution of the power flow problem and stability analysis.
Visit to load dispatch centre is suggested.

Note: A student to perform any 8-10 Experiments.

Suggested List of Experiments:

1. *Short circuit calculations and calculations of circuit breaker ratings for a power system network.*
2. *a) Y-bus formation using Matlab/PSCAD/Power world.*
   b) Z-bus formulation using Matlab/PSCAD/Power world.
3. *Load flow analysis by Gauss Seidal method.*
4. *Load flow analysis by Newto Raphson method*
5. *To obtain power system stability on High Voltage Alternating current (HVAC) system with the help of Flexible Alternating Current Transmission Systems (FACTS) devices using Matlab/PSCAD/Power world.*
6. *Optimal Capacitor placement on a system having variable reactive power and low voltage profile.*
7. *To obtain relay co-ordination on a power system.*
8. *To find synchronous reactances (Transient, sub-transient) during fault analysis.*
9. *To study the characteristics of a distance relay.*
10. *To study and design a synchronous machine for stability study using swing equation using Matlab/PSCAD/Power world.*

BTEE-621-18	***Minor Project (Project -1)***	**0L:0T:6P**	**3 credit**

Internal Marks: 30 *External Marks: 20* *Total Marks: 50*

Course Outcomes:
At the end of this course, students will demonstrate the ability to:
(i) Apply and verify basic scientific principals and technologies.
(ii) Identify the scope of interdisciplinary knowledge
(iii) Make and design a prototype which is preferably a working model

Guidelines

1) A group of 3-4 students under the mentorship of a teacher to make a minor project. Interdisciplinary projects to be encouraged.
2) The project title and scope to be decided and presented in first 2nd/3rd weeks of the semester.
3) The progress of the project to be evaluated (internal) in 8th/9th week of the semester.
4) A draft of the project report to be prepared and the project to be evaluated (internal) 12th/13th week of the semester.
5) The project report and the project to be submitted in the department at the time of external evaluation.

BMPD-601-18	**Mentoring and Professional Development of Students**	**0L:1T:0P**	**Non-credit**

Internal Marks: 50 *External Marks: -* *Total Marks: 50*

The assigned mentor to engage the students to in activities such as:

1) Identification of any one of the local environmental concern and propose workable solution for it.
2) Arrange an Industrial visit of 2-3 days
3) Expert/Invited talk pertaining to recent industrial development.
4) Preparation of database for placement activities.
5) Resume preparation.

The mentor to keep record of all activities (including those mentioned above) and assign internal marks accordingly.

Programme Electives

VI (even)	PE-2	BTEE-603A-18	Electromagnetic Waves	3L:0T:0P	3
VI (even)	PE-2	BTEE-603B-18	Power System Dynamics and Control	3L:0T:0P	3
VI (even)	PE-2	BTEE-603C-18	Electrical Drives	3L:0T:0P	3
VI (even)	PE-2	BTEEE-603D-18	Digital Control Systems	3L:0T:0P	3
VI (even)	PE-3	BTEE-604A-18	High Voltage Engineering	3L:0T:0P	3
VI (even)	PE-3	BTEE-604B-18	Power System Reliability	3L:0T:0P	3
VI (even)	PE-3	BTEE-604C-18	Line-Commutated and Active PWM Rectifiers	3L:0T:0P	3
VI (even)	PE-3	BTEEE-604D-18	Embedded Systems	3L:0T:0P	3

BTEE-603A-18	Electromagnetic Waves	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

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

Module 1: Transmission Lines (8 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 (9 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 (9 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)

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves 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 (8 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. Introduction to antennas.

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.

BTEE-603-B-18	Power System Dynamics and Control	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

- (i) Understand the problem of power system stability and its impact on the system.
- (ii) Analyse linear dynamical systems and use of numerical integration methods.
- (iii) Model different power system components for the study of stability.
- (iv) Understand the need and plan the methods to improve stability.

Module 1: Introduction to Power System Operations (4 hours)

Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.

Module 2: Analysis of Linear Dynamical System and Numerical Methods (5 hours)

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

Module 3: Modeling of Synchronous Machines and Associated Controllers (12 hours)

Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

Module 4: Modeling of other Power System Components (10 hours)

Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads.

Module 5: Stability Analysis (11 hours)

Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Planning Measures for Enhancing System Stability. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

Text/Reference Books

1. K.R. Padiyar, “Power System Dynamics, Stability and Control”, B. S. Publications, 2002.
2. P. Kundur, “Power System Stability and Control”, McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Prentice Hall, 1997.

BTEE-603C-18	**Electrical Drives**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

(i) Understand the characteristics of dc motors and induction motors.
(ii) Understand the principles of speed-control of dc motors and induction motors.
(iii) Apply the knowledge of power electronics to understand the working of dc-dc converters.
(iv) Apply the knowledge of control system for the speed control of electrical machines.
(v) Understand the working of AC and DC drives

Module 1: DC motor characteristics (6 hours)

Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation, regenerative braking.

Module 2: Chopper fed DC drive (12 hours)

Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.

Multi-quadrant DC drive **:** Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive.

Module 3: Closed-loop control of DC Drive (8 hours)

Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.

Module 4: Induction motor characteristics (6 hours)

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.

Module 5: Scalar control or constant V/f control of induction motor (8 hours)

Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

Text / References:

1. G. K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall, 1989.
2. R. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, Prentice Hall,2001.
3. G. K. Dubey, Fundamentals of Electrical Drives, CRC Press, 2002.
4. W. Leonhard, Control of Electric Drives, Springer Science & Business Media, 2001.

BTEEE-603D-18	Digital Control Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

- use ordinary differential equations and z-transformation to model physical systems,
- translate a set of performance specifications given in words to a formal description of a design problem, and then design a suitable feedback-controller using design tools
- design digital controllers, assess their design through the constraint specifications

Module 1: Sampling and Reconstruction (8 hours)
Introduction, Examples of Data control systems, Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.
Z TRANSFORMS: Introduction, Linear difference equations, pulse response, Z transforms, Theorems of Z Transforms, inverse Z transforms, Modified Z Transforms.

Module 2: Z-plane analysis of discrete-time control system (10 hours)
Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis
of sampled data systems, mapping between s-plane and z-plane.
State Space Analysis: State Space Representation of discrete time systems, pulse transfer function matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state space equations

Module 3: Controllability and Observability (8 hours)
Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between controllability and observability, Controllability and Observability conditions for Pulse Transfer Function

Module 4: Stability Analysis (8 hours)
Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury
stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.

Module 5: Design of Discrete Time Control System by Conventional Methods (8 hours)
Transient and steady: State response Analysis, Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane.

Text/References:
1. B. C.Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2. K. Ogata, Discrete Time Control Systems,Prentice Hall, 2/e, 1995.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
4. G. F. Franklin, J. D.Powell and M. L. Workman, Digital Control of Dynamic Systems,
5. Addison Wesley, 1998,Pearson Education,Asia, 3/e, 2000.K. J.Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design,Prentice Hall, 3/e, 1997.

BTEE-604A-18	High Voltage Engineering	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

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

Module 1: Breakdown in Insulating materials (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 (9 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 (9 Hours)
Generation of high voltages, generation of high D C and AC voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Module 4: Measurements of High Voltages and Currents (8 Hours)
Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module 5: Lightning and Switching Over-voltages (8 Hours)
Charge formation in clouds, stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

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. 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

BTEE-604B-18	Power System Reliability	3L:0T:0P	3 credits

Internal Marks: 40   External Marks: 60   Total Marks: 100

Course Outcome: This course covers the following topics

(i) Understand the basic quantitative reliability analysis
(ii) Understand the reliability modeling and analysis of electric power systems.
(iii) Knowledge of reliability assessment for elements of transmission system.
(iv) Understand the risk analysis in power system planning.

Module 1: General reliability modelling and evaluation (8 hours)

Introduction to probability and stochastic processes; system modelling for reliability; methods of reliability assessment: state space, cut-set and tie-set analysis, decomposition; Monte Carlo simulation: non-sequential and sequential; synchronous and asynchronous timing, Analysis of risk in power systems; understanding of causes and remedial measures.

Module 2: Reliability modeling and analysis of electric power systems (10 hours)

Bulk power systems, distribution systems, and industrial systems. Component modeling: generator modeling, transmission line modeling, load modeling; capacity outage table; probability and frequency distributions; unit addition algorithm; load modeling algorithm. Generation adequacy assessment using discrete convolution: discrete convolution of generation and load models; generation reserve model.

Module 3: Power System Reliability (8 hours)

Basic Notions of Power System Reliability- sub systems, reliability indices, outage classification, value of reliability tools, Concepts and methodologies, power system structure, Reliability based planning in power systems, Effect of failures on power system, Planning criteria, Risk analysis in power system planning, multi-state systems.

Module 4: Reliability of Generation Systems (8 hours)

Capacity outage calculations, reliability indices using the loss of load probability method, unit commitment and operating constraints, optimal reserve management, single and multi-stage expansion.

Module 5: Reliability Assessment for Elements of Transmission and Transformation Systems (8 hours)

Reliability indices of substations based on the overload capability of the transformers, evaluation and analysis of substation configurations.

Text Books:

1. C. Singh, P. Jirutitijaroen and J. Mitra, Electric Power Grid Reliability Evaluation: Models and Methods. Wiley-IEEE Press, Hoboken, NJ: 2019. ISBN: 9781119486275.
2. R. Ramakumar, Engineering Reliability: Fundamentals and Applications. Prentice Hall. J. Endrenyi, Reliability Modeling in Electric Power Systems. Wiley.
3. Shahidehpour M, Yamin H, Li z, Markey operations in electric power systems Forecasting, Scheduling, and Risk Management, John Wlley & sons
4. R. Billinton, R. Allan, Reliability evaluation of power systems, Plenum Press New York, 1996.
5. Computational Methods in Power system Reliability, D. Elmakias, Springer-Verlag

BTEE-604C-18	**Line-Commutated and Active PWM Rectifiers**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

(i) Analyse controlled rectifier circuits.

(ii) Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.

(iii) Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

Module 1: Diode rectifiers with passive filtering (8 Hours)

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape, effect of source inductance; commutation overlap.

Module 2: Thyristor rectifiers with passive filtering (9 Hours)

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module 3: Multi-Pulse converter (9 Lectures)

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase AC, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module 4: Single-phase AC-DC single-switch boost converter (8 Hours)

Review of dc-dc boost converter, power circuit of single-switch AC-DC converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module 5: AC-Dc bidirectional boost converter (8 Hours)

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Text / References:

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2001.

BTEEE-604D-18	Embedded Systems	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:
At the end of this course, students will be able to
(i) Design embedded system with appropriate hardware and software components
(ii) Analyze, program and use a typical ARM processor and its peripherals.
(iii) Interface various real time sensors using different communication protocols.
(iv) 4.Apply the study of embedded technology to product design.

Module 1: Introduction to Embedded Systems (08)
Characteristics of Embedding Computing Applications, Concept of Real time Systems.Challenges in embedded system design, design process.Embedded System Architecture-Instruction Set Architecture of ARM.(ATOM processor, Introduction to Tiva family etc.)

Module 2: Designing Embedded Computing Platform (09)
Bus Protocols, Bus Organization, Memory Devices and their Characteristics, Memory mapped I/O, I/O Devices, I/O mapped I/O, Timers and Counters, Watchdog Timers, Interrupt Controllers, Interrupt programming, DMA Controllers, GPIO control, A/D and D/A Converters, Need of low power for embedded systems, Mixed Signals Processing.

Module 3: Programming Embedded Systems (10)
Basic Features of an Operating System, Kernel Features, Real-time Kernels, Processes and Threads, Context Switching, Scheduling, Shared Memory Communication, Message-Based Communication, Real-time Memory Management, Dynamic Allocation, Device Drivers, Real-time Transactions and Files, Realtime OS (VxWorks, RT-Linux, Psos).

Module 4: Network Based Embedded Applications (8)
Embedded Networking Fundamentals, Layers and Protocols, Distributed Embedded Architectures, Internet-Enabled Systems, IoT overview and architecture, Interfacing Protocols (like UART, SPI, I2C, GPIB, FIREWIRE, USB,). Various wireless protocols and its applications: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, WiFi. CAN. Overview of wireless sensor networks and design examples

Module 5: Case Studies (07)
Case studies: Programming in Embedded C,Embedded system design using Arduino, ATOM processors, Galileo, STM and Tiva based embedded system applications.

Text/References:
1. Alexander G. Dean, Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach" ARM Education media Publishers,Ist edition, 2017.
2 Rob Toulson and Tim wilmshrrst "Fast and Effective Embedded Systems Design: Applying the ARM
mbed "Newnes Publishers , IInd edition, 2017.
3. Wayne Wolf, "Computers as Components- Principles of Embedded Computing System Design", Morgan Kaufmann Publishers, IInd edition, 2008.
4. Lyla B. Das, Embedded Systems –An Integrated Approach , Pearson Publishers, Ist edition, 2013
5. Marwedel Peter, Embedded System Design, Springer Publishers, Ist edition,2006.
6. Barry Crowley, Modern Embedded Computing Morgan Kaufmann Publishers, Ist edition, 2012

Open Elective

Sr. No.	Course Code	Semester	Course Title	L	T	P	Hours/ Week	Credits
1.	OEEE-101-18	Odd	Fundamentals in Control systems	3	0	0	3	3
2.	OEE-102-18	Odd-	Power Electronics	3	0	0	3	3
3.	OEEE-103-18	Odd	Energy Management	3	0	0	3	3
4.	OEE-104-18	Odd	Renewable Energy Sources	3	0	0	3	3
5.	OEEE-201-18	Even	Electric Drives	3	0	0	3	3
6.	OEE-201-18	Even	Electric Machines	3	0	0	3	3
7.	OEEE-202-18	Even	Materials in Electrical Systems	3	0	0	3	3
8.	OEEE-203-18	Even	Electric Safety	3	0	0	3	3

OEEE-101-18	Fundamentals in Control Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

(i) Understand the concept of control of systems

(ii) Modeling of linear-time-invariant systems using transfer function and state-space representations.

(iii) Understand the concept of stability and its assessment for linear-time invariant systems.

Module 1: Introductory Concepts (8 hours)

Plant, Systems, Servomechanism, regulating systems, disturbances, Open loop control system, closed loop control systems, linear and non-linear systems, time variant and invariant, continuous and sampled-data control systems, Block diagrams, some illustrative examples.

Module 2: Modeling (9 hours)

Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical, mechanical analogies. Use of Laplace transforms, Transfer function, concepts of state variable modeling. Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

Module 3: Time Domain Analysis (9 hours)

Typical test – input signals, Transient response of the first and second order systems. Time domain specifications, Dominant closed loop poles of higher order systems. Steady state error and coefficients, pole-zero location and stability, Routh-Hurwitz Criterion.

Module 4: Root Locus Technique (8 hours)

The extreme points of the root loci for positive gain. Asymptotes to the loci, Breakaway points, intersection with imaginary axis, location of roots with given gain and sketch of the root locus plot.

Module 5: Frequency Domain Analysis (8 hours)

Closed loop frequency response, Bode plots, stability and loop transfer function. Frequency response specifications, Relative stability, Relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Text/References:

1. M. Gopal, Control Systems: Principles and Design, McGraw Hill Education, 1997.
2. B. C. Kuo, Automatic Control System, Prentice Hall, 1995.
3. K. Ogata, Modern Control Engineering, Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, Control Systems Engineering, New Age International, 2009.

OEE-102-18	Power Electronics	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:
At the end of this course, students will demonstrate the ability to
(i) Knowledge of power semiconductor switches
(ii) Understand the working of various types of converters
(iii)Apply the ac-dc and dc-dc converter in field

Module 1: Semiconductor Devices Construction and Characteristics (8 hours)
Introduction to Thyristor family: SCR, DIACs, TRIACs Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs), Light Activated SCRs (LASCRs), Reverse Conducting Thyristor, (RCT), Asymmetrical SCR (ASCR), Gate turn-off Thyristors (GTOs), Integrated Gate- Commutated Thyristors (IGCTs), MOS controlled Thyristors (MCTs) Power Integrated circuits (PICs), Intelligent Modules

Module 2: Thyristor Fundamentals (10 hours)
Construction of SCR, Operating modes, Two transistor analogy, Static & dynamic characteristics, Gate characteristics, Turn on & turn off methods (Commutation methods), Series and Parallel operations of SCRs : Need, String efficiency, Issues, Static and Dynamic Equalizing circuit and Means to minimize the effect of mis-match Isolation of gate and base drive using pulse transformer and Optocouplers Gate Drive/Triggering circuits: R trigger, RC trigger, Cosine Triggering, UJT and Programmable UJT as an oscillator and triggering circuit based on them Ratings, Cooling and Heat sinks, Thermal Modeling, di/dt and dv/dt protection,

Module 3: Phase Controlled (AC to DC) Converters (8 hours)
Review of half-wave and full-wave diode rectifier (with RL load); Principle of phase-controlled converter operation; Operation of 1-phase half wave converter with R, RL and RLE load; 1- phase full wave converter: Center-tapped and Bridge Configuration; Gating Requirements.

Module 4: Operation and analysis of 1-phase Semi-converter/Half controlled converter (8 hours)
Operation of half wave converter; Full wave fully controlled converters: Semi-controlled converter; Dual Converter: Principle and operation; 1-phase and 3-phase configurations.

Module 5: DC to DC Converters (8 hours)
The chopper, Basic principle of DC chopper, Classification of DC choppers, Principle, operation, and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost), Application of DC-to-DC converters.

Text/References:
1. M. D. Singh and K. B. Khanchandani, Power electronics, TMH, New Delhi, 2nd ed., 2007.
2. M. H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India, 3rd ed., 2003.

3. V. Subramanyam, Power Electronics – Devices, Converters and Applications, New Age International Publishers Pvt. Ltd., Bangalore, 2nd ed. 2006.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 2012.
5. N. Mohan, Undeland and Robbins, Power Electronics – Converters, Applications and Design, John Willey & sons, Inc., 3rd ed., 2003.
6. V. R. Moorthi, Power Electronics, Oxford University press, 2005.
7. G. K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, Thyristorised Power Controllers, New Age International Ltd. Publishers, 1986 (Reprint 2008).
8. P.T. Krein, Elements of Power Electronics, Oxford University Press, 1998.
9. G. K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi, 2nd ed. 2001.

OEEE-103-18	Energy Management	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

(i) Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing
(ii) Ability to analyses the viability of energy conservation projects
(iii) Capability to integrate various options and assess the business and policy environment regarding energy conservation and energy auditing

Module 1: Introduction (8 hours)
Perspective of Energy Sources (conventional and non-conventional), Power generation: Hydro, thermal, Utilization & demand projections, World and Indian Scene, Energy thresholds for subsistence and development**.** Overall Structure of EPS, Electric Tariffs

Module 2: Energy Availability Studies (10 hours)
Forecasting methodologies, Pattern of energy consumption. Energy input equipment processes, Electric load, Lightening and power, Energy confinement, Energy storage, Cogeneration, Integrated energy system Need and Objectives, Energy Conservation Technologies, Demand Side Management, Supply Side Management, Computer Aided Management System. ECO Assessment and Evaluation Methods

Module 3: Energy Conservation (9 hours)
Basic Principles, Energy conservation planning, Energy efficiency analysis of system, Energy conservation through controls, Predictive and preventive maintenance, Electric energy conservation in generation, transmission and distribution, Electric Energy conservation in building heating and lighting, Energy conservation in domestic gadgets and transport. Energy efficient motors, Power factor improvement.

Module 4: Energy Audit (8 hours)
Energy Audit concepts, aims, Energy flow diagram, Strategy of Energy audit, elements, Measurements, Energy economic analysis, Evaluation of energy conserving opportunities, Energy Audit Reporting Format, BIS Specifications, Energy Audit of Building Systems.

Module 5: Captive power Generation (7 hours)
Introduction, advantages, constraints, options, types of captive power plants, Energy wheeling, promotion of captive power generation in India.

Text/References:
1. B. K. Hogbe, Analysis and Design of Energy Systems, PHI.
2. U. Rathore, Energy Management, Kataria Publications.
3. A.W. Culp Principles of Energy Conversion, TMH.
4. A. P. W. Thumann, Plant Engineers and Manager Guide to Energy Conservation, 7E, UNR, 1977.
5. M. C Macedo, Energy Management and Control System, Vol. I, II, John Wiley.

OEE-104-18	Renewable Energy Sources	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:
At the end of this course, students will demonstrate the ability to
(i) Knowledge of the basic properties of different renewable sources of energy and technologies
(ii) Knowledge of the main elements of technical systems designed for utilization of renewable sources of energy
(iii) Understand the advantages and disadvantages of different renewable sources of energy
(iv) Understand the energy potential of renewable sources of energy,

Module 1: Solar Radiation and Solar Energy Collection (12 hours)
Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.
Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

Module 2: Wind Energy (8 hours)
Energy availability of wind, wind resources, principle of wind energy conservation. Wind turbine site and its site selection, classification of wind turbine, characteristics of wind turbine.

Module 3: Bio-Mass (8 hours)
Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

Module 4: Geothermal Energy (6 hours)
Resources, types of wells, methods of harnessing the energy, potential in India.

Module 5: Ocean Energy (8 hours)
OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

Text/References:
1. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers
2. Renewable Energy Resources – Twidell &Wier, CRC Press (Taylor & Francis)
3. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
4. Ramesh & Kumar, Renewable Energy Technologies / /Narosa
5. D. P. Kothari, K. C. Singhal, Renewable energy sources and emerging technologies, P.H.I.

OEEE-201-18	Electric Drives	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

(i) The students will be able to select a drive for a particular application. They will familiarize with the various control techniques employed for controlling drives with ac and dc motors.

Module 1: Introduction to electric drives (8 hours)
Block diagram, advantages of electric drives, Dynamics of motor load system, fundamental equations, and types of load: classification of load torque, four quadrant operation of drives.

Module 2: DC motor drives (10 hours)
Constant torque and constant power operation, separately excited dc motor drives using controlled rectifiers, single phase semi converter and single phase fully controlled converter drives. Three phase semi converter and fully controlled converter drives.

Module 3: Chopper controlled DC drives (8 hours)
Analysis of single quadrant chopper drives. Cyclo-converters for drive applications, different types, basic principle.

Module 4: Three phase induction motor speed control (8 hours)
Using semiconductor devices. Stator voltage control, stator frequency control, Stator voltage and frequency control (v/f). Rotor chopper speed control.

Module 5: Introduction to converters (8 hours)
Voltage source inverter fed induction motor drives, Current source inverter fed induction motor drives. Concept of space vector.

Text/References:

1. S.B. Dewan, G. R. Slemon, A. Strauvhen, "Power semiconductor drives", John Wiley and sons
2. Dr. P. S. Bimbra "Power electronics", Khanna publishers
3. J. M. D. Murphy "Thyristor control of AC drives"
4. N. K. De, P. K. Sen "Electric drives" Prentice Hall of India 2002
5. Ned Mohan, Tore m Undeland, William P Robbins, "Power electronics converters applications and design", John Wiley and Sons.
6. Pillai S. K. "A first course on electric drives", Wieley Eastern Ltd, New Delhi
7. Vedam Subrahmanyam, "Electric Drives", MC Graw Hill Education, New Delhi
8. W. Shepherd, L. N. Hulley and D. T. Liang, "Power Electronocs and motor control", Second Edition, Cambridge University Press, 1995.

OEE-201-18	**Electric Machines**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

(i) Summarize the basics of Single-Phase Machines
(ii) Acquire knowledge about testing and applications of induction motors.
(iii) Understand the concepts of Steeper Motors, construction, modes of operation and characteristics
(iv) Understand the basic concept of DC Machines and its torque slip characteristics
(v) Explain the basic concepts of universal and repulsion motors, construction, application.
(vi)

Module 1: Poly-phase AC Machines (9 hours)
Construction of three phase induction motors, types of three-phase induction motors, rotor induced emf, power flow in induction motor, equivalent circuit of induction motor, Torque - speed characteristics, condition of maximum torque, tests on induction motor: measurement of DC resistance, No-load test, blocked rotor test. Braking: Plugging, rheostatic braking and regenerative braking.

Module 2: Single phase Induction Motors (8 hours)
Pulsating magnetic field, double revolving field, starting methods of single-phase induction motor, Construction, starting characteristics and applications of split phase, capacitor start, capacitor run, capacitor-start capacitor-run and shaded pole motors. Servo motors: DC Sevomotor and AC servo motor.

Module 3: Stepper Motors (8 hours)
Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications. Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.

Module 4: Permanent Magnet Machines (9 hours)
Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM ac motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators and applications

Module 5: Special Machines (8 hours)
Construction, principle of operation of: Single phase AC commutator motor, Switched Reluctance motor, brushless dc motor, hysteresis Motor, Synchronous reluctance motor, Linear induction motor.

Text / Reference Books:

1. P.S. Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers.
2. P.C. Sen, Principles of Electrical Machines and Power Electronics, John willey & Sons, 2001

3. G. K. Dubey, Fundamentals of Electric Drives, Narosa Publishing House, 2001.
4. C. G. Veinott, Fractional and Sub-fractional horsepower electric motors, McGraw Hill International, 1987
5. M.G. Say, Alternating current Machines, Pitman & Sons.

OEEE-202-18	Materials in Electrical Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

(i) Study of different types of conductors and their characteristic
(ii) Study of different insulators.
(iii) Study of different magnetic materials and their processing.
(iv) Knowledge of different semi-conductors and Super conductors
(v) Knowledge of specials engineering material

Module 1: Conductors Classification (8 hours)

High conductivity, high resistivity materials, fundamental requirements of high conductivity materials and high resistivity materials, mobility of electron in metals, factors affecting conductivity and resistivity of electrical material, thermoelectric Effect: See back effect, Peltier effect, commonly used high conducting materials: copper, aluminum, bronze brass properties and characteristics, constantan, platinum and nichrome properties, characteristics and applications, material used for AC and DC machines.

Module 2: Dielectric Materials and Insulators (10 hours)

Properties of gaseous, liquid and solid dielectric, dielectric as a field medium, electric conduction in gaseous, liquid and solid dielectric, breakdown in dielectric materials, mechanical and electrical properties of dielectric materials, classification of insulation (Solid) and application in AC and DC machines, solid electrical insulating materials.

Module 3: Magnetic Materials (9 hours)

Basic terms, classification of magnetic material: diamagnetic, paramagnetic, ferromagnetic, anti- ferromagnetic and amorphous material, hysteresis loop, magnetic susceptibility. coercive force, curie temperature, magneto-striction, factors affecting permeability and hysteresis loss, common magnetic materials: soft and hard magnetic materials, electric steel, sheet steel, cold rolled grain-oriented silicon steel, hot rolled grain- oriented silicon steel.

Module 4: Semi-Conductors and Superconductors (8 hours)

General concepts, energy bands, types of semiconductors: intrinsic Semiconductors, extrinsic Semi-conductors, compound semiconductor, amorphous semiconductor, hall effect, drift, mobility, diffusion in Semiconductors, semi-conductors, and their applications. Superconductors: Superconductivity, properties of superconductors.

Module 5: Special purpose materials (7 hours)

Nickel iron alloys, high frequency materials, permanent magnet materials, feebly magnetic materials, ageing of a permanent magnet, effect of impurities, Losses in Magnetic materials, Refractory Materials, Structural Materials, Radioactive Materials, Galvanization, and Impregnation of materials.

Text/Reference Books:

1. A. J. Dekker, Electrical Engineering Materials, PHI Publication.
2. C. S. Indulkar and S. Thiruvengadam, An Introduction to Electrical Engineering Materials, S. Chand & Co., India.
3. Ian P. Hones, Material Science for Electrical & Electronics Engineers, Oxford University Press.
4. L. Solymar and D. Walsh, Electrical Properties of Materials, Oxford University Press-New Delhi.
5. S. P. Seth and P. V. Gupta, A Course in Electrical Engineering Materials, Dhanpat Rai & Sons.
6. S.K. Bhattacharya, Electrical and Electronic Engineering Materials: Khanna Publishers, New Delhi.
7. T.T.T.I Chennai, Electrical Engineering Materials, Tata MacGraw Hill.

OEEE-203-18	**Electric Safety**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:
At the end of this course, students will demonstrate the ability to
(i) Understand the Indian electricity rules and their significance
(ii) Learn about electrical safety installation, testing and commission.
(iii) Gain skills in identifying the presence of electrical hazards, implementing measures to minimize risks and develop skills in investigative techniques for determining the cause of electrical accidents, fires and explosions.
(iv) Understand about electrical safety in distribution system

Module 1: Introduction and Statutory Requirements (10 hours)
Introduction: electrostatics, electromagnetism, stored energy, energy radiation and electromagnetic interference, working principles of electrical equipment-Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety, first aid, cardiopulmonary resuscitation (CPR).

Module 2: Electrical Safety - Indian Standards (6 hours)
National electrical safety code ANSI. Code of Practice for Electrical Wiring Installation, Earthing and Lightning arrester for Alternating Current System

Module 3: Electrical Hazards (10 hours)
Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity. Energy leakage, clearances and insulation, classes of insulation, voltage classifications, excess energy, current surges, safety in handling of war equipments over current and short circuit current-heating effects of current-electromagnetic forces, corona effect, static electricity definition, sources, hazardous conditions, control, causes of fire and explosion-ionization, spark and arc-ignition energy, lightning, hazards, lightning arrestor, installation, earthing, specifications, earth resistance, earth bit maintenance.

Module 4: Protection Systems (8 hours)
Fuse, circuit breakers and overload relays, protection against over voltage and under voltage, safe limits of amperage, voltage, safe distance from lines-capacity and protection of conductor, joints and connections, overload and short circuit protection-no load protection-earth fault protection, earthing devices.

Module 5: Electrical Safety (8 hours)
Safety in handling handheld electrical appliances tools and protection, earthing devices, safety in handling hand held electrical appliances tools and medical equipment.

Text/References:
1. Fordham Cooper, W., Electrical Safety Engineering, Butterworth and Company, London
2. Accident prevention manual for industrial operations, National Safety Council, N.S.C., Chicago.
3. Indian Electricity Act and Rules, Government of India.

List of Humanities & Social Sciences Including Management

Sr. No.	Course Code	Course Title	Hours per week	Credit
1.	HSMC-103-18	Education, Technology and Society	3L:0T:0P	3
2.	HSMC-104-18	History of Science and Technology in India	3L:0T:0P	3
3.	HSMC-113-18	Values and Ethics	3L:0T:0P	3
4.	HSMC-118-18	Introduction to Women's and Gender Studies	3L:0T:0P	3
5.	HSMC-123-18	Human Relations at Work	-	-
6.	HSMC-124-18	Sanskrit Bhasa	3L:0T:0P	3
7.	HSMC (MME-303)	Law and Engineering	3L:0T:0P	3

Note: (a) On account of a prerequisite, course HSMC-123-18 Human Relations at Work not to be considered. (b) As per AICTE Humanities & Social Sciences Including Management are 3 credit course hence Hours per week to be 3L:0T:0P.

HSMC-103-18	Education, Technology and Society	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

OBJECTIVES:

The goal of the proposed course is to enable students:

i. To explore the various ways in which technology has and may in future affect not only the mode of delivery of education but also the very nature of education.

ii. To understand the requirement of (a) education for becoming an effective member of the society (b) To fulfill the potential of a learner to the fullest without too much thought of an individual's responsibility towards the contemporary society.

COURSE TOPICS:

Unit 1: Necessity of education for human life, Impact of education on society

Unit 2: Nature and scope of education (Gurukul to ICT driven), Emotional intelligence Domains of learning, Approaches to learning, Learning outcomes

Unit 3: Role of education in technology advancement.

Unit 4: Technology and society; management of technology; technology transfer

Unit 5: Ethical and value implications of education and technology on individual and society

COURSEOUTCOME:

On successful completion of this course, the students will be able to integrate their technical education for betterment of society as well motivates them to lead a good human life.

REFERENCEBOOKS:

Education and Social order by Bertr and Russel

Theories of learning by Bower and Hilgard

Technology and Society by Jan L Harrington

HSMC-104-18	History of Science and Technology in India	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Unit-I CONCEPTS AND PERSPECTIVES

- Meaning of History
- Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history
- Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.
- Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

Unit-II: HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA

- Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

Unit-III: SCIENCE AND TECHNOLOGY IN ANCIENT INDIA

- Technology in pre-historic period
- Beginning of agriculture and its impact on technology
- Science and Technology during Vedic and Later Vedic times
- Science and technology from 1stcentury AD toC-1200.

Unit-IV: SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA

- Legacy of technology in Medieval India, Interactions with Arabs
- Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
- Astronomy and Mathematics: interaction with Arabic Sciences
- Science and Technology on the eve of British conquest

Unit-V: SCIENCE AND TECHNOLOGY IN COLONIAL INDIA

- Science and the Empire
- Indian response to Western Science
- Growth of techno-scientific institutions

Unit-VI: SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA

- Science, Technology and Development discourse
- Shaping of the Science and Technology Policy
- Developments in the field of Science and Technology
- Science and technology in globalizing India
- Social implications of new technologies like the Information Technology and Biotechnology

HSMC-113-18	Values and Ethics	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Definition and classification of values: Extrinsic values, Universal and Situational values, Physical, Environmental, Sensuous, Economic, Social, Aesthetic, Moral and Religious values.
2. Concepts related to values: Purusartha, Virtue, Right, duty, justice, Equality, Love and Good.
3. Egoism, Altruism and universalism.
4. The Ideal of Sarvodaya and Vasudhaiva Kutumbakam. The Problem of Sustenance of value in the process of Social, Political and Technological changes.
5. The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

BOOKS SUGGESTED

1. डॉनित्यानंदमिश्र : नीतिशास्त्र (Motilal Banarasidas, 2005)
2. डॉवेदप्रकाशवर्मा : नीतिशास्त्रकेमूलसिद्धांत, (Allied Publication, Delhi, 1977)
3. डॉसंगमलालपांडे : नीतिशास्त्रकासर्वेक्षण (सेंट्रलपब्लिशिंगहादस, इलाहाबाद-2005)
4. Little, William, : An Introduction of Ethics (allied Publisher, Indian Reprint 1955)
5. William, K Frankena : Ethics (Prentice Hall of India, 1988)
6. Dr. Awadesh Pradhan : Mahamana ke Vichara. (B.H.U., Vanarasi-2007)

HSMC-118-18	Introduction to Women's and Gender Studies	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Unit-I : Concepts

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

Unit-II: *Feminist Theory*

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

Unit-III: *Women's Movements: Global, National and Local*

Rise of Feminism in Europe and America.
Women's Movement in India.

Unit-IV: *Gender and Language*

Linguistic Forms and Gender.
Gender and narratives.

Unit-V: *Gender and Representation*

Advertising and popular visual media.
Gender and Representation in Alternative Media.
Gender and social media.

HSMC-124-18	Sanskrit Bhasa	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

- शब्दस्वरूप एवंभेद
- उच्चारण–स्थान एवंप्रयत्न
- पदसंरचना
  (क) पदस्वरूप, भेद एवंप्रयोग
  (ख) सुवन्तपद
  (ग) तिङन्तपद
- वाक्यसंरचना
  (क) वाक्यस्वरूप, भेद एवंप्रयोग
  (ख) कर्तृवाच्य
  (ग) कर्मवाच्य
  (घ) भाववाच्य
- शब्द–अर्थ–सम्बन्ध
  (क) शक्ति
  (ख) लक्षणा
  (ग) गौणी, व्यञ्जना, तात्पर्यआदि
- कारकपरिचय
  (क) कारकस्वरूप, भेद एवंप्रयोग
  (ख) विभक्तियोंकाअर्थ
- सन्धिपरिचय–सन्धिस्वरूप, भेद एवंप्रयोग
- स्मासपरिचय–स्वरूप, भेद एवंप्रयोग
- शाब्दबोध–प्रक्रिया एवंकारण
  आकांक्षा, योग्यता, आसत्ति, तात्पर्यज्ञान
- संस्कृतसम्भाषण

HSMC (MME-303)	Law and Engineering	**3L:0T:0P**	**3 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

The aim of this course is to provide a basic understanding of the legal concepts and issues relevant to those wishing to practice as Engineers.

1. THE LEGAL SYSTEM: SOURCES OF LAW AND THE COURTSTRUCTURE:
- 1.1 Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law- Principles taken from decisions of judges constitute binding legal rules.
- 1.2 The Court System in India and Foreign Courtiers. (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court)
- 1.3 Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration.

2. BASIC PRINCIPLES OF CONTRACTLAW

3. SALE OF GOODSLAW

4. BUSINESSORGANISATIONS:
- 4.1 SOLE TRADERS (Business has no separate identity from you, all business property belongs to you)
- 4.2 PARTNERSHIPS: There are three types of Partnerships: Limited Liability Partnership, General Partnership, Limited Partnerships
- 4.3 COMPANIES:
  - The nature of companies.
  - Classification of companies.
  - Formation of companies.
  - Features of a public company.
  - Carrying on business.
  - Directors –Their Powers and Responsibilities/Liabilities.

5. LAWS RELATING TO INDUSTRIAL POLLUTION ACCIDENT, ENVIRONMENTAL PROTECTION, HEALTH AND SAFETY AT WORK.

6. PATENTLAW.

7. INFORMATION TECHNOLOGY LAW AND CYBERCRIMES.

8. LAW AND SOCIETY: INTERDISCIPLINARY NATURE OF LAW, LEGAL IDEOLOGIES/PHILOSOPHY/ SCHOOLS OFJURISPRUDENCE.

9. CONSTITUTIONAL LAW: THE SUPREME LAW OF THELAND.

10. CASE STUDIES: IMPORTANT LEGAL DISPUTES AND JUDICIALLITIGATIONS.

Semester: VII/VIII

[Fourth Year]

BTEE-721-18/ BTEEE-721-18	Project-2	0L:0T:12P	6 credits

Internal Marks: 120 **External Marks: 80** **Total Marks: 200**

Course Outcomes:
At the end of this course, students will demonstrate the ability to:
CO 1 Apply and verify basic scientific principals and technologies.
CO 2 Application of interdisciplinary knowledge
CO 3 To identify possible product that can be made from the project for commercial purpose.

The objective of Project-2 including dissertation is to enable the student to extend further the investigative study taken up under Project-1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a supervisor from the department alone or jointly with a supervisor drawn from R&D laboratory/industry/other department in the institute. This is expected to provide a good training for the student (s) in R&D work and technical leadership. The assignment to normally include:

1) In depth study of the topic assigned in the light of the report prepared under Project-1
2) Review and finalization of the approach to the assigned topic
3) Preparing an action plan for conducting the investigation, including teamwork
4) Need based detailed analysis/modelling/simulation/design/problem solving/experiment.
5) Final development of product/process, testing, results, conclusions and future directions/scope
6) Preparing a dissertation in the standard format for being evaluated by the department.
7) Final seminar presentation before a departmental committee.
8) Preparing a paper for conference presentation/publication in journals, if possible.

Note: The report submitted should be within the philosophy of science and ethics and publication ethics. Proper citation to be done so as to avoid plagiarism.

BMPD-701-18	**Mentoring and Professional Development of Students**	**0L:1T:0P**	**0 credits S/US**

Internal Marks: 50 **External Marks: 00** **Total Marks: 50**

The assigned mentor to engage the students to in activities such as:

1) Identification of any one of the local social concern and propose workable solution for it.
2) Expert/Invited talk pertaining to recent industrial development.
3) Explore scope of higher education: GATE/GRE/CAT/civil services/engineering services etc.
4) Resume finalization.

The mentor to keep record of all activities (including those mentioned above) and assign internal marks accordingly.

Programme Electives

BTEE-701A-18	Electrical Energy Conservation and Auditing	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 Understand the current energy scenario and importance of energy conservation. Understand the concepts of energy management.

CO 2 Understand the methods of improving energy efficiency in different electrical systems.

CO 3 Understand the concepts of different energy efficient devices.

Module 1: Energy Scenario (6 Hours)

Commercial and non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module 2: Energy Management & Audit (6 Hours)

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel energy substitution, energy audit instruments. Material and energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module 3: Energy Efficiency in Electrical Systems (7 Hours)

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module 4: Energy Efficiency in Industrial Systems (8 Hours)

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module 5: Energy Efficient Technologies in Electrical Systems (**8Hours**)

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books

1. Guide books for National Certification Examination for Energy Manager/Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org).

BTEE-701B-18	Computer Aided Power System Analysis	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:
At the end of this course, students will demonstrate the ability to:
CO 1 To introduce computer applications in the analysis of power systems.
CO 2 To understand the solution methods and techniques used in power system studies.
CO 3 To solve numerically the complex IEEE bus networks and the energy flows.

Module 1: Graphical Concepts and Network Matrices (8 Hours)
Overview of graph theory -tree, co-tree and incidence matrix, development of network matrices from Graph theoretic approach. Review of solution of linear system of equations by Gauss Jordan method, Gauss elimination, LDU factorization.
Ybus and Zbus formulation through graphical concepts. Bus building algorithm for Zbus formation.

Module 2: Power Flow Studies (16 Hours)
Inversion of YBUS for large systems using LDU factors, Tinney's Optimal ordering. Review of Gauss-Seidel Iteration using YBUS, Newton-Raphson method, Fast Decoupled Load Flow (FDLF) DC load flow, Three-phase load flow.

Module 3: Optimal Power Flow (6 Hours)
Basics concepts, active/reactive power objectives (Economic dispatch, MW and MVAr loss minimization)-applications-security constrained optimal power flow.

Module 4: Fault Analysis (10 Hours)
Network fault calculations using ZBUS and YBUS Table of factors, Algorithm for calculating system conditions after fault-three phase short circuit, three-phase to ground, double line to ground, line to line and single line to ground fault.

Module 5: Contingency Evaluation (6 Hours)
Contingency evaluation using ZBUS and YBUS Table of factors. State estimation-least square and weighted least square estimation methods for linear systems.

Text/References
1. A. R. Bergen, and V. Vittal, “Power Systems Analysis”, Pearson Higher Education, 2nd edition.
2. G. L. Kusic, “Computer Aided Power System Analysis”, Prentice Hall of India, 1989.
3. J. J. Grainger, and W. D. Stevenson, “Power System Analysis”, Tata McGraw-Hill Series in Electrical and Computer Engineering.
4. M. A. Pai, “Computer Techniques in Power Systems Analysis”, Tata McGraw-Hill, 2nd edition, 2005.
5. D P Kothari and I J Nagrath, Modern Power System Analysis, Tata Mc Graw Hill, Fourth Edition, 2013.

BTEE-701C-18	Power Quality and FACTS	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 To introduce the fundamental concepts relevant to harmonics and grounding.

CO 2 To enable the students to understand the factors that cause the power quality and harmonics problems in the distribution system.

CO 3 To provide basic understanding of the emerging power electronics technologies for power utility applications.

CO 4 To enable students to design power electronics circuit that can control active and reactive power flow.

Module 1: Introduction (4 Hours)

Introduction to power quality, voltage quality. Overview of power quality, Power quality phenomena and classification of power quality issues.

Module 2: Power Quality Measures and Standards (6 Hours)

THDTIF-DIN-message weights-flicker factor transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, EMC standards and recommended practices.

Module 3: Harmonic device modelling (10 Hours)

Harmonics background, basic concepts, Fourier analysis. Harmonics-individual and total harmonic distortion-RMS value of harmonic waveform-triplex harmonic-important harmonic introducing devices-Transformer, Three-phase power converters arcing devices-saturable devices. Harmonic distortion due to fluorescent lamps. Effect of power system harmonics on power system equipment and loads

Module 4: Fundamentals of transmission system (8 Hours)

Fundamentals of AC power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

Module 5: Shunt Compensation & Series Compensation (14 Hours)

Principles of shunt compensation: Variable impedance type and switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

Design principles of static series compensation: Series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).

Text/References

1. R. C. Dugan, S. Santoso, M. F. McGranaghan, and H. W. Beaty, “Electrical Power System Quality”, McGraw Hill, 2003.
2. A. Ghosh, and G. Ledwich, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2012.
3. C. Sankaran, “Power Quality”, CRC Press, 2002.
4. S. Sivanagaraju, and S. Satyanarayana, “Electric Power Transmission and Distribution Pearson Education”, Dorling Kindersley Pvt. Ltd., Pearson Education, 2009.
5. G. Narain, N. Hingorani, and L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, Wiley, 2000.

BTEEE-701D-18	Microcontroller and PLC	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

CO 1 To understand the working of a microprocessor/controller.
CO 2 To learn configuring and using different peripherals in a digital system.
CO 3 To understand the implementation of 8051 core
CO 4 To compile and debug a Program in PLC

Module 1: Introduction (8 Hours)
Microprocessor, Micro-controllers and their comparison. The 8051 Architecture: Introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts

Module 2: 8051 Assembly Language Programming (8 Hours)
The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions)

Module 3: 8051 Microcontroller Design (8 Hours)
Micro-controller specification, external memory and memory space decoding, reset and clock circuits, expanding input and output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission

Module 4: Microcontroller Applications (8 Hours)
Interfacing keyboards, displays, Digital-to-Analog (D/A) and Analog-to-Digital (A/D), multiple interrupts, serial data communications, introduction to the use of assemblers and simulators Embedded Systems: Introduction to PLDs and FPGA- architecture, technology and design issues, implementation of 8051 core.

Module 5: Programmable Logic Controllers (PLC) (10 Hours)
Introduction, operation of PLC, difference between PLC and Hardwired system, difference between PLC and Computer, relay logic and ladder logic, ladder commands and examples of PLC ladder diagram realization, PLC timers, PLC counters, PLC classification.

Text/References books:
1. Kenneth J Ayola, The 8051 Micro Controller- Architecture, Programming and Application, Penram International Publication
2. John B Peatman, Design with Micro Controller, Tata McGraw Hill
3. Ray A. K. and Bhurchandi K. M., Advanced Microprocessors and Peripherals; Architecture, Programming and Interfacing, Tata McGraw Hill
4. Mazidi M. A. and Mazidi J. G., The 8051 Micro-controller and Embedded System, Pearson Education.
5. Udayashankara V. and Mallikarjunaswamy M.S., 8051 Microcontroller Hardware, Software and Applications, TataMcGraw Hill Education Pvt. Ltd., (2010)
6. Surekha Bhanot, Process Control, Oxford Higher Education.
7. Otter, Job Dan, Programmable Logic Controller, P.H. International, Inc, USA
8. Dunning Gary, Introduction to PLCs, Tata McGraw Hill

BTEE-702A-18	Computational Electromagnetics	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 Understand the basic concepts of Electrostatics and Electromagnetics.
CO 2 Understand computational techniques for computing fields.
CO 3 Apply the techniques to simple real-life problems.

Module 1: Introduction (7 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 (7 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 and Applications (12 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.

Applications**:** 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.. S. Sivanagaraju, and S. Satyanarayana, "Electric Power Transmission and Distribution Pearson Education", Dorling Kindersley Pvt. Ltd., Pearson Education, 2009.
5. G. Narain, N. Hingorani, and L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley, 2000.

BTEEE-702B-18	High Voltage DC Transmission Systems	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 To understand the principles and types of HVDC system.

CO 2 To analyze and understand the concepts of HVDC converters.

CO 3 To get knowledge about Planning of DC power transmission and comparison with AC power transmission.

Module 1: Direct Current (DC) power transmission technology (8Hours)

Introduction, comparison of Alternating Current (AC) and Direct Current (DC) transmission, application of DC transmission, application of DC transmission, description of DC transmission system, Configurations, planning for High Voltage Direct Current (HVDC) transmission, modern trends in DC transmission. Introduction to Device: Thyristor valve, valve tests, recent trends.

Module 2: Converter and HVDC System Control (10 Hours)

Pulse number, choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, characteristics of a twelve-pulse converter, detailed analysis of converters with and without overlap. General, principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link, power control, higher level controllers, telecommunication requirements.

Module 3: Converter faults and protection (8 Hours)

Introduction, converter faults, protection against over-currents, over-voltages in a converter station, surge arresters, protection against over-voltages.

Module 4: Reactive Power and Harmonics Control (8 Hours)

Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters.

Module 5: Power Flow Analysis in AC/DC Systems (8 Hours)

Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – case study.

1. E. Kuffel, E. and M. Abdullah,High Voltage Engineering, Pergamon Press
2. C. L. Wadhwa, High Voltage Engineering, New Age Publications.
3. K.R. Padiyar, HVDC Power Transmission Systems: Technology and System Interactions, New Age Internationa**l**
4. E.W. Kimbark, High Voltage DC Transmission, Wiley-Interscience
5. V. Kamaraju and Naidu M.S., High Voltage Engineering, Tata McGraw-Hill Educatio**.**

BTEE-702C-18	Control Systems Design	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 Understand various design specifications.

CO 2 Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).

CO 3 Design controllers using the state-space approach.

Module 1: Design Specifications (6 hours)

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

Module 2: Design of Classical Control System in the time domain (8 hours)

Introduction to compensator. Design of lag, lead lag-lead compensator in time domain. Feedback and feed forward compensator design. Feedback compensation. Realization of compensators.

Module 3: Design of Classical Control System in frequency domain (8 hours)

Compensator design in frequency domain to improve steady state and transient response. Feedback and feed forward compensator design using bode diagram.

Module 4: Design of PID controllers (6 hours)

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback-Feed forward control.

Module 5: Control System Design in state space (12 hours)

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation principle.

Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

Text and Reference Books

1. N. S. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath, and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall of India, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall of India, 1995.
6. J. J. D'Azzo, and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R. T. Stefani, and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

BTEEE-702D-18	Optimization Techniques	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

- **CO 1** Understand the importance of optimization of industrial process management
- **CO 2** Apply the basic concepts of mathematics to formulate an optimization problem
- **CO 3** Analyze and appreciate variety of performance measures for various optimization problems
- **CO 4** Use of MATLAB to solve optimization problems

Module 1: Introduction (10 Hours)

Introduction to optimization: Engineering application of optimization-statement of an optimization problem-optimal problem formulation-classification of optimization problem. optimum design concepts: definition of global and local optima, optimality criteria, review of basic calculus concepts-global optimality.

Linear programming methods for optimum design: Review of Linear programming methods for optimum design, Post optimality analysis, Application of LPP models in design and manufacturing.

Module 2: Algorithms (10 Hours)

Optimization algorithms for solving unconstrained optimization problems, Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method. Optimization algorithms for solving constrained optimization problems, direct methods, penalty function methods, steepest descent method, Engineering applications of constrained and unconstrained algorithms.

Module 3: Modern methods of Optimization (8 Hours)

Genetic Algorithms, Simulated Annealing, Ant colony optimization, Tabu search, Neural-Network based Optimization, Fuzzy optimization techniques, Applications. Use of Matlab to solve optimization problems.

Module 4: Transportation and Assignment Problems (6 Hours)

Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

Module 5: Inventory and Queuing Model (8 Hours)

Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

Text/References books

1. K. Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, 2000.
2. J. Arora, "Introduction to Optimization Design", Elsevier Academic Press, 2004.
3. R. Saravanan, "Manufacturing Optimization through Intelligent Techniques", Taylor & Francis (CRC Press), 2006.
4. G. Hardley, "Linear Programming", Narosa Book Distributors Private Ltd., 2002.
5. S. S. Rao, "Engineering Optimization, Theory and Practice", New Age International Publishers, 2012.

BTEE-703A-18	Industrial Electrical Systems	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.

CO 2 Understand various components of industrial electrical systems.

CO 3 Analyze and select the proper size of various electrical system components.

Module 1: Electrical System Components (8 Hours)

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, 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 a lighting scheme for 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 (12 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.

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. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.
5. Web site for IS Standards.

BTEE-703B-18	Restructured Power Systems	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

CO 1 To impart knowledge about the restructuring and deregulation of power sector.
CO 2 To introduce the fundamental concepts relevant to transmission pricing, models of deregulation,
CO 3 To introduce the fundamental concepts relevant to ancillary services and international experience of deregulation.
CO4 To enable the students to understand the basic concepts of deregulation.

Module 1: Introduction (7 Hours)
Basic concept and definitions, privatization, restructuring, transmission open access, Fundamentals of Deregulation, Restructuring Models and Trading Arrangements, Different Models of Deregulation, Operation and control, wheeling charges and pricing. Motivations for Restructuring the Power Industry; Understanding the restructuring process, entities involved, the levels of competition, marketplace mechanisms, sector-wise major changes required.

Module 2: The Philosophy of Market Models (9 Hours)
Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design, Cournot, Bertrand and Stackelberg competition model. Independent System Operator (ISO), Open Access Transmission Systems

Module 3: Transmission Congestion Management (10 Hours)
Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC, TRM, CBM, ATC calculation using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs), Implications of nodal pricing, Price area congestion management.

Module 4: Ancillary Service Management (10 Hours)
Type and Classification of ancillary services, Sources of reactive power, Black start capability service, Provisions of ancillary services, Markets for ancillary services, Co-optimization of energy and reserve services, Loss of opportunity cost, International practices of ancillary services.

Module 5: Deregulation Scenario (6 Hours)
Differential Models of Deregulation UK model, California Model, China, California, Australian and New Zeeland Models, Deregulation in Asia including India.

Text/References:

1. Kankar Bhattacharya, Math H J. Bollen and Jaap E. Daalder, “Operation of Restructured Power Systems”, Springer, 2001.
2. M. Shahidehpour and M. Alomoush, “Restructured Electric Power Systems – Operations, Trading and Volatility”, CRC Press, 2001.
3. Loi Lei Lai (Ed), “Power System Restructuring and Deregulation: Trading, performance and Information Technology,” John Wiley publications, 2001.
4. D. Krischen and G. Strabac “Fundaments of Power System Economics” New York, Wiley 2004

BTEE-703C-18	Advanced Electric Drives	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Course Outcomes:

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

CO 1 Understand the operation of power electronic converters and their control strategies.
CO 2 Understand the vector control strategies for ac motor drives
CO 3 Understand the implementation of the control strategies using digital signal processors.

Module 1: Power Converters for AC drives (10 hours)

PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

Module 2: Induction motor drives (10 hours)

Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

Module 3: Synchronous motor drives (6 hours)

Modelling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Module 4: Permanent magnet motor drives (10 hours)

Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

Module 5: DSP based motion control (6 hours)

Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Text / References:

1. B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, 2003.
2. P. C. Krause, O. Wasynczuk, and S. D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, 2013.
3. H. A. Taliyat, and S. G. Campbell, “DSP based Electromechanical Motion Control”, CRC press, 2003.
4. R. Krishnan, “Permanent Magnet Synchronous and Brushless DC motor Drives”, CRC Press, 2009.

BTEEE-703D-18	Transducers and its Applications	3L:0T:0P	3 credits

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

- **CO 1** Understand the selection criteria of a transducer for a particular application.
- **CO 2** Understand the working and principle of operation of resistive, capacitive and inductive transducers.
- **CO 3** Explain the working and fundamental concepts in principle of operation of active transducers.
- **CO 4** Understand the working of Optical transducers

Module 1: Measurements and Basics of a Transducer (7 Hours)
Basic electronic measuring system, Units and Standard, Transduction principles, Classification of transducers, General transducers characteristics, Criteria for transducer selection.

Module 2: Resistive and Capacitive Transducers (12 Hours)
Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors,Types of capacitive transducer, Principles of operation, construction, theory, advantages and disadvantages and applications, of capacitive transducers based upon familiar equation of capacitance.Industrial applications of resistive and capacitive transducers

Module 3: Inductive Transducers (7 Hours)
Types of Inductive transducer, Principles of operation, construction, Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT and RVDT

Module 4: Active Transducers (9 Hours)
Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: Thermocouple, Piezo-electric transducer, Magneto-strictive transducer, Hall effect transducer,and their applications.

Module 5: Other Transducers (7 Hours)
Optical transducers: Photo-emissive, Photo-conductive and Photo-voltaic cells, Digital Transducers: Optical encoder, Shaft encoder, and their applications.

Text/References:

1. Murty DVS, Transducers & Instrumentation, Prentice Hall of India
2. Sawhney AK, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai and Sons
3. Kalsi HS, Electronic Instrumentation, Tata McGraw Hill
4. Doebelin EO, Measurement Systems: Application and Design, Tata McGraw Hill

One Semester Training

<table>
<tr><th colspan="4">Semester VII/VIII [Fourth year]</th><th colspan="5">Branch: Electrical & Electronics Engineering</th></tr>
<tr><td rowspan="3">BTEEE-721-18/
BTEE-721-18/
One Semester Training</td><td colspan="5">Marks</td><td rowspan="4">Total Marks</td><td rowspan="4">Credits</td></tr>
<tr><td colspan="4">Internal</td><td>External</td></tr>
<tr><td colspan="2">Mid- semester</td><td colspan="2">End-semester</td><td></td></tr>
<tr><td>Evaluation by</td><td>Institute</td><td>Industry</td><td>Institute</td><td>Industry</td><td>External Examiner</td></tr>
<tr><td>Software Training & Project</td><td>50</td><td>25</td><td>50</td><td>25</td><td rowspan="2">200</td><td rowspan="2">500</td><td rowspan="2">16</td></tr>
<tr><td>Industrial Training & Project</td><td>50</td><td>25</td><td>50</td><td>25</td></tr>
<tr><td>Total</td><td colspan="4">300</td><td>200</td><td>500</td><td>16</td></tr>
</table>

Note: In case a student goes for pre-placement training and such a training could be only software based or only hardware based or a combination of both. The report/evaluation in such a case to be made accordingly.

Semester: VIII

[Fourth Year]

BTEEE-801-18/ BTELE-801-18	**Optical Fibers and Communication**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

- **CO 1** Recognize and classify the structures of Optical fiber and types.
- **CO 2** Discuss the channel impairments like losses and dispersion.
- **CO 3** Classify the Optical sources and Optical detectors to calculate various coupling losses and to design a fiber optic link respectively.
- **CO 4** Familiar with concepts of WDM, optical amplifiers and Soliton Propagation.

Module 1: Introduction (8 Hours)
Need of Fiber Optic Communications, Evolution of Light wave Systems, Channel Multiplexing, Modulation Formats, Optical Communication Systems, Light wave System Components; Optical Fibers as a Communication Channel, Optical Transmitters, Optical Receivers

Module 2: Pulse dispersion (9 Hours)
Material and Waveguide dispersion. Polarization Mode Dispersion. Absorption, scattering and bending losses. Dispersion Shifted Fibers, Dispersion Compensating Fibers.

Module 3: Optical sources (9 Hours)
LEDs and Laser Diodes. Optical Power Launching and Coupling. Source to Fiber coupling, Fiber to Fiber joints. Misalignments. Schemes for coupling improvement.

Module 4: Optical detectors ((8 Hours)
PIN and Avalanche photodiodes, Photo detector noise, Optical receivers. Digital link design: Power budget and Rise time budget. Attenuation and Dispersion limit.

Module 5: WDM Concepts (8 Hours)
Optical Amplifiers: EDFA. Nonlinear effects: Self Phase Modulation, Nonlinear Schrodinger Equation. Optical Soliton.

Text/References:
1.G. Keiser, “Optical Fiber Communications (5/e)”, McGraw Hill, 2013.
2. A. Ghatak & K. Thygarajan, “Introduction to Fiber Optics”, Cambridge, 1999.
3. G. P. Agarwal, “Fiber Optic Communication Systems”, (4/e), Wiley, 2010.
4. M. M. K. Liu, “Principles and Applications of Optical Communications”, Tata McGraw Hill, 2010. 5. A. Selvarajan, S. Kar and T. Srinivas, “Optical Fiber Communication Principles and Systems”, Tata McGraw Hill, 2006.

BTEEE-802-18/ BTEE-701C-18	**Power Quality and FACTS**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

CO 1 To introduce the fundamental concepts relevant to harmonics and grounding.
CO 2 To enable the students to understand the factors that cause the power quality and harmonics problems in the distribution system.
CO 3 To provide basic understanding of the emerging power electronics technologies for power utility applications.
CO 4 To enable students to design power electronics circuit that can control active and reactive power flow.

Module 1: Introduction (4 Hours)
Introduction to power quality, voltage quality. Overview of power quality, Power quality phenomena and classification of power quality issues.

Module 2: Power Quality Measures and Standards (6 Hours)
THDTIF-DIN-message weights-flicker factor transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, EMC standards and recommended practices.

Module 3: Harmonic device modelling (10 Hours)
Harmonics background, basic concepts, Fourier analysis. Harmonics-individual and total harmonic distortion-RMS value of harmonic waveform-triplex harmonic-important harmonic introducing devices-Transformer, Three-phase power converters arcing devices-saturable devices. Harmonic distortion due to fluorescent lamps. Effect of power system harmonics on power system equipment and loads

Module 4: Fundamentals of transmission system (8 Hours)
Fundamentals of AC power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

Module 5: Shunt Compensation & Series Compensation (14 Hours)
Principles of shunt compensation: Variable impedance type and switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.
Design principles of static series compensation: Series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).

Text/References
1. R. C. Dugan, S. Santoso, M. F. McGranaghan, and H. W. Beaty, “Electrical Power System Quality”, McGraw Hill, 2003.
2. A. Ghosh, and G. Ledwich, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2012.
3. C. Sankaran, “Power Quality”, CRC Press, 2002.
4. S. Sivanagaraju, and S. Satyanarayana, “Electric Power Transmission and Distribution Pearson Education”, Dorling Kindersley Pvt. Ltd., Pearson Education, 2009.
5. G. Narain, N. Hingorani, and L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, Wiley, 2000.

BTEEE-803-18/ BTELE-803-18	**Microwave Engineering**	**3L:0T:0P**	**3 credits**

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

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

- **CO 1** Apply the basic knowledge of waveguide and microwave resonator circuits.
- **CO 2** Assess the methods used for generation and amplification of the microwave power.
- **CO 3** Critically analyze the operating principles and performances of the microwave semiconductor devices.
- **CO 4** Identify the suitable microwave power sources of given specification for the selected application.

Module 1: Introduction to the characteristics of Microwave Systems (9 Hours)
Limitations of conventional vacuum tubes, Klystrons: Re-entrant cavities, Two cavity klystron, Velocity modulation process, Bunching process, Power output and efficiency; Multi-cavity klystron, Reflex klystron-Velocity modulation process, Mode Characteristics, Electronic admittance spiral.

Module 2: Travelling Wave Tubes (TWT) (8 Hours)
Travelling-wave tubes: Slow-wave structures, Helix TWT- Amplification process, Convection current, Wave modes and gain; coupled cavity TWT, Backward wave oscillator.

Module 3: Cross Field Devices (7 Hours)
Magnetrons- Principle of operation, characteristics, Hull cut-off condition; Carcinotron, Gyrotron.

Module 4: Microwave transistors and FETs (9 Hours)
Microwave bipolar transistors-Physical structures, characteristics, Power-frequency limitations; Microwave tunnel diode, Microwave unipolar transistor – Physical structure, principle of operation, characteristics, High electron-mobility transistors

Module 5: Microwave Devices (9 Hours)
Transferred electron and Avalanche transit-time devices: Gunn diode, Gunn diode as an oscillator. IMPATT, TRAPATT and BARITT.

Text/References:
1.S.Y.Liao, “Microwave Devices and Circuits (3/e)”, PHI, 2005.
2. R. F. Soohoo, “Microwave Electronics”, Wesley publication, 1971.
3. R.E.Collin, “Foundations for Microwave Engineering (2/e)”, Wiley India, 2007.
4. D.M.Pozar,” Microwave Engineering (3/e)”, Wiley India, 2009.
5. K C Gupta, Indian Institute of Technology, Kanpur,” Microwaves”, Wiley Eastern Limited, 1995.

BTEEE-812-18/ BTELE-812-18	**Technical Report Writing and Presentation**	**0L:0T:8P**	**4 credits**

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Guidelines:

1. The teaching load of the subject to be equally distributed among all the faculty members of the department.
2. A team of maximum 3 students to write a technical report based on Case Study of an Industry / Industrial project/ Study or implementation of IEEE/IEC/Indian standard / Product design.
3. The report is to be written under the supervision of Faculty member of concerned department, a Co-supervisor from Industry can be taken, if needed. (it should be different from that of the Project-1/Minor project and project-2/major project report.
4. Basic report structure
   - Title page.
   - Summary.
   - Table of contents.
   - Introduction.
   - Body of the report.
   - Conclusions and recommendations.
   - References and appendices.
   - Appendix: Slides of the presentation
5. The presentation of the report is to be made in the Department prior to the External Evaluation.
6. Effort to be made for the publication in Conference/an article in a periodical.

BTEEE-820-18/ BTELE-820-18	Optical Fibers and Communication lab	0L:0T:4P	2 credits

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

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

- **CO 1** To perform experiments based on optical communication in order to understand in depth concepts of latest communication system.
- **CO 2** To study various types of optical sources and light detectors.
- **CO 3** To know methods of slicing and connecting techniques of optical fibers.
- **CO 4** To study different types of losses in optical fibers.

Students have to perform at-least 8-10 experiments from the list given below.

1. Study and measurement of Attenuation and Loss in optical fiber.
2. Study and measurement of bending loss in optical fiber.
3. Study and measurement of numerical aperture of optical fiber.
4. Measurement of optical power using optical power meter.
5. To Study the transmission of TDM signal through optical fiber.
6. To determine the bit rate of the optical fiber link.
7. Study of various multiplexing techniques.
8. To determine the BER of wireless system using M-ARY (BPSK,QPSK,8PSK,16PSK) and QAM technique.
9. To learn fiber splicing techniques and to become familiar with the use of optical time domain reflectometry in characterizing optical fibers.
10. To establish fiber optic analog link and to study the relationship between the input signal & received signal.
11. To study the VI characteristics of fiber optic source and Photo Detector.
12. Simulation of an optical communication system & calculation of its BER and Q factor using simulator

BMPD-801-18	**Mentoring and Professional Development of Students**	**0L:1T:0P**	**0 credits S/US**

Internal Marks: 50 **External Marks: 00** **Total Marks: 50**

The assigned mentor to engage the students to in activities such as:

1) Identification of any one of the local social concern and propose workable solution for it.
2) Expert/Invited talk pertaining to recent industrial development.
3) Explore scope of self-employment/entrepreneurship.

The mentor to keep record of all activities (including those mentioned above) and assign internal marks accordingly.

List of e-books for Under Graduate programme of (Electrical Engineering/Electrical and Electronics Engineering/Electronics and Electrical Engineering.

Title	Author(s)	Publisher
Control Systems, 2nd ed	Anand Kumar	PHI Learning
Advanced Control Systems	Sarkar	PHI Learning
Analog And Digital Communications	Tl Singal	Tata McGraw-Hill Education Private Ltd
Analog Communication	Ramakishna Rao	Tata McGraw-Hill Education Private Ltd
Basic Electrical & Electronics Engineering	Muthusubramanian	Tata McGraw-Hill Education Private Ltd
Basic Electrical And Electronic Eng I	Chakrabarti	Tata McGraw-Hill Education Private Ltd
Basic Electrical And Instrumentation Engineering	Salivahnan	Tata McGraw-Hill Education Private Ltd
Basic Electrical Engineering, 3/E	Kothari	Tata McGraw-Hill Education Private Ltd
Basic Electrical, Electronics And Measurement Engineering (Au)	Salivahnan	Tata McGraw-Hill Education Private Ltd
Basic Electronics And Devices Jntu 2018	Salivahan	Tata McGraw-Hill Education Private Ltd
Circuit Analysis	Nagoorkani	Tata McGraw-Hill Education Private Ltd
Circuit Theory (Au 2016)	Nagoorkani	Tata McGraw-Hill Education Private Ltd
Circuit Theory (Au)	Nagoorkani	Tata McGraw-Hill Education Private Ltd
Circuit Theory And Networks	Sp Gosh And Ak Chakraborty	Tata McGraw-Hill Education Private Ltd
Circuit Theory And Networks (MU 2018)	Singh	Tata McGraw-Hill Education Private Ltd
Circuit Theory: Continuous and Discrete-time Systems Elements of Network Synthesis	Kuriakose	PHI Learning
Computer Techniques In Power System Analysis	Pai	Tata McGraw-Hill Education Private Ltd
Control Engineering: Theory and Practice	Bandyopadhyay	PHI Learning
Control System Components	Desai	PHI Learning
Control Systems Wbut Jun'13	Purkait	Tata McGraw-Hill Education Private Ltd
Digital Communication	P Ramakrishna Rao	Tata McGraw-Hill Education Private Ltd
Digital Electronics - Au 2018	Mandal	Tata McGraw-Hill Education Private Ltd
Digital Image Processing	Jayaraman, S.	Tata McGraw-Hill Education Private Ltd

List of e-books for Under Graduate programme of (Electrical Engineering/Electrical and Electronics Engineering/Electronics and Electrical Engineering.

Title	Author(s)	Publisher
Digital Signal Processing	Salivahanan	Tata McGraw-Hill Education Private Ltd
Digital Signal Processors	Venkataramani	Tata McGraw-Hill Education Private Ltd
Electric Drives: Concepts & Appl, 2/E	Subrahmanyam	Tata McGraw-Hill Education Private Ltd
Electric Machines	Kothari	Tata McGraw-Hill Education Private Ltd
Electric Power Distribution	Pabla	Tata McGraw-Hill Education Private Ltd
Electrical Cir Ana-I JNTUK14	Sudhakar	Tata McGraw-Hill Education Private Ltd
Electrical Circuit Analysis (Jntu)	Sudhakar, A.	Tata McGraw-Hill Education Private Ltd
Electrical Circuit Analysis, 2nd ed.	Mahadevan & Chitra	PHI Learning
Electrical Circuit Analysis, 2nd ed.	Mahadevan & Chitra	PHI Learning
Electrical Machines	Chakrabarti	Tata McGraw-Hill Education Private Ltd
Electrical Machines	Bhattacharya, S. K.	Tata McGraw-Hill Education Private Ltd
Electrical Machines	Bhattacharya, S. K.	Tata McGraw-Hill Education Private Ltd
Electrical Machines, 3/E	Bhattacharya, S. K.	Tata McGraw-Hill Education Private Ltd
Electrical Networks	Singh, Ravish	Tata McGraw-Hill Education Private Ltd
Electrical Power Distribution Systems	Kamaraju	Tata McGraw-Hill Education Private Ltd
Electronic Circuits - 1 - Au 2018	Salivahanan	Tata McGraw-Hill Education Private Ltd
Electronic Circuits I - Au'15	Salivahanan	Tata McGraw-Hill Education Private Ltd
Electronic Devices & Circuit Jntu A 2014	Salivahanan	Tata McGraw-Hill Education Private Ltd
Electronic Devices And Circuits	Salivahanan	Tata McGraw-Hill Education Private Ltd
Electronic Devices And Circuits	Venkata Rao	Tata McGraw-Hill Education Private Ltd
Electronic Devices And Circuits Jntu 2018	Salivahnan	Tata McGraw-Hill Education Private Ltd
Electronic Instrumentation, 3e	Kalsi	Tata McGraw-Hill Education Private Ltd
Electronic Principles, 7/E	Malvino	Tata McGraw-Hill Education Private Ltd

List of e-books for Under Graduate programme of (Electrical Engineering/Electrical and Electronics Engineering/Electronics and Electrical Engineering.

Title	Author(s)	Publisher
Handbook Of Switchgears	Bhel	Tata McGraw-Hill Education Private Ltd
High Voltage Engineering	Naidu	Tata McGraw-Hill Education Private Ltd
Hvdc Transmission	Kamakshaiah	Tata McGraw-Hill Education Private Ltd
Instrumentation And Control Systems	Raju	Tata McGraw-Hill Education Private Ltd
Introduction to Electrical Engineering	Ganguly	PHI Learning
Linear IC Applications	Salivahnan	Tata McGraw-Hill Education Private Ltd
Linear Integrated Circuits	Salivahanan	Tata McGraw-Hill Education Private Ltd
Microprocessers And Microcontrollers	Nagoorkani	Tata McGraw-Hill Education Private Ltd
Microwave Engineering	Vasuki	Tata McGraw-Hill Education Private Ltd
Microwave Engineering	Das, Annapurna	Tata McGraw-Hill Education Private Ltd
Modern Control Engineering	Roy Choudhury	PHI Learning
Modern Digital Electronics, 4/E	Jain	Tata McGraw-Hill Education Private Ltd
Modern Power System Analysis	Kothari, Nagrath	Tata McGraw-Hill Education Private Ltd
Network Analysis & Synth	Ghosh	Tata McGraw-Hill Education Private Ltd
Network Analysis and Synthesis	Anand Kumar	PHI Learning
Network Analysis and Synthesis	Anand Kumar	PHI Learning
Network Theory (Bput)	Satpathy, P. K.	Tata McGraw-Hill Education Private Ltd
Power Electronics	Hart, Daniel	Tata McGraw-Hill Education Private Ltd
Power Electronics	Asghar	PHI Learning
Power Electronics	Singh	Tata McGraw-Hill Education Private Ltd
Power Electronics, 1e	Soumitra Kumar Mandal	Tata McGraw-Hill Education Private Ltd
Power Electronics: Devices and Circuits, 2nd ed.	Jagannathan	PHI Learning
Power System Engineering	Kothari	Tata McGraw-Hill Education Private Ltd

List of e-books for Under Graduate programme of (Electrical Engineering/Electrical and Electronics Engineering/Electronics and Electrical Engineering.

Title	Author(s)	Publisher
Power System Protection & Switchgear	Oza	Tata McGraw-Hill Education Private Ltd
Power System Protection And Switchgear	Badri Ram, Dn Vishwakarma	Tata McGraw-Hill Education Private Ltd
Principles of Electronics	Ganguly	PHI Learning
Renewable Energy Sources: Their Impact on Global Warming and Pollution	Abbasi & Abbasi	PHI Learning
Signals & Systems 2e	Nagrath	Tata McGraw-Hill Education Private Ltd
Signals And Systems	Nagoor Kani, A.	Tata McGraw-Hill Education Private Ltd
Signals And Systems	Nagoorkani	Tata McGraw-Hill Education Private Ltd
Theory and Problems of Basic Electrical Engineering, 2nd ed.	Kothari & Nagrath	PHI Learning
Training Manual For Industrial Training Institutes And Centres	Dge&T	Tata McGraw-Hill Education Private Ltd
Transformers	Bhel	Tata McGraw-Hill Education Private Ltd
VLSI Design	Sahu	Tata McGraw-Hill Education Private Ltd

Procedure for (a) Minor Degree (b) Honors Degree

(a) Student to opt for Minor degree in relevant programme in 3rd semester
(b) Students having no backlog up till 3rd/4th Semester will be eligible for opting for Honors Degree in the relevant Programme in the 5th Semester.

From the available relevant on-line SWAYAM/ MOOCS courses for the session, the list of the courses to be considered for Minor degree/Honors degree in relevant programme to be approved by BoS.

The number of credits for SWAYAM/MOOCS courses for Minor degree in in relevant programme to be as per the credits mentioned on the certificate of the respective SWAYAM/ MOOCS course.

The following step are proposed to be followed for credits earned through SWAYAM/MOOCS courses:
i) For each semester the student to take up online SWAYAM/MOOCS courses approved by the BoS.
ii) Take permission (written) from Institute/Department for registration.
iii) On successful completion of each SWAYAM/MOOCS in each semester the student to submit self-attested copy of certificate (on-line/hard) to Institute/ Department.
iv) The Institute/Department to verify the certificate and there after Institute/ Department to convey to the Examination Branch through the office of Dean Academics.
v) On obtaining the minimum credits the student will be eligible for Minor Degree in relevant programme.

In case of non-availability of SWAYAM/MOOCS courses the student can earn the minimum credits for (a) Minor Degree from Professional Core / Elective Courses (b) Honors degree from Professional Elective Courses other than those taken up for the concerned B.Tech Programme

The list of (i) Professional Core Courses (ii) Professional Elective Courses, clearly indicating odd and even semester is available in the Teaching Scheme.