GITAM

(DEEMED TO BE UNIVERSITY)

(Estd. u/s 3 of the UGC Act, 1956)

BENGALURU ❋ HYDERABAD ❋ VISAKHAPATNAM

NAAC Accredited with A+ Grade

REGULATIONS AND SYLLABUS
of
Master of Technology
in
Power System and Automation

(w.e.f 2019 -20 admitted batch)

A University Committed to Excellence

M.Tech. in Power System and Automation
REGULATIONS
(w.e.f. 2019-20 admitted batch)

1. ADMISSION

Admission into M.Tech. in Power System and Automation program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITYCRITERIA

2.1 A pass in B.E./B.Tech./AMIE in EEE or its equivalent.

2.2 Admissions into M.Tech. will be based on the following:

(i) Score obtained in GAT (PG), if conducted.
(ii) Performance in Qualifying Examination / Interview.
(iii) Candidates with valid GATE score shall be exempted from appearing for GAT (PG).

2.3 The actual weightage to be given to the above items will be decided by the authorities at the time of admissions.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from 2015-16 admitted batch and revised with effect from academic year 2019-20 in order to promote:

- Student centered Learning
- Activity based learning
- Students to learn courses of their choice
- Cafeteria approach

3.2 Learning objectives and outcomes are outlined for each course to enable a student to know what he/she will be able to do at the end of the program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

i) Core Courses (compulsory) which give exposure to a student in core subjects related area.

ii) Program Electives.

iii) Open Electives

iv) Mandatory and Audit Courses

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture / Tutorial hour per week.
- One credit for two hours of Practicals per week.

4.4 The curriculum of the four semesters M.Tech. program is designed to have a total of 68 credits for the award of M.Tech. degree.

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in the academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the semester-end examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 65% and 74% on genuine grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and semester-end examination (60 marks).

8.2 A student has to secure a minimum of 40% in any theory course in the two components (ref. 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Practical/ Project Work/ Viva voce/ Seminar etc. course are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

8.4 Audit courses are assessed through continuous evaluation for satisfactory or not satisfactory only. No credits will be assigned.

Table 1: Assessment Procedure

S.No.	Component of Assessment	Marks Allotted	Type of Assessment	Scheme of Evaluation
1	Theory Courses	40	Continuous Evaluation	i) Thirty (30) marks for mid Semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations. Sixty (60) marks for Semester-end examinations
		60	Semester-end Examination	
	Total	100		

2	Practical Courses	100	Continuous Evaluation	i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.
3	Technical Seminar (II Semester)	100	Continuous Evaluation	Through five periodic seminars of 20 marks each
4	Project Work (III Semester)	100	Continuous Evaluation	i) Forty (40) marks for periodic assessment on originality, innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation for defending the project, before a panel of examiners. iii) Thirty (30) marks for final report presentation and viva-voce, by a panel of examiners*.
5	Project Work (IV Semester)	50	Continuous Evaluation	i) Twenty (20) marks for periodic assessment on originality innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Fifteen (15) marks for mid-term evaluation for defending the project, before a panel of examiners*. iii) Fifteen (15) marks for interim report presentation and viva-voce.
		50	Semester-end Examination	Fifty (50) marks for final project report and viva-voce examination assessed by external examiners.
	Total	100		

6	Audit Courses	100	Continuous Evaluation	Audit courses are assessed for PASS or FAIL only. No credits will be assigned to these courses. If a student secures a minimum of 40 out of 100 marks during continuous evaluation, he / she will be declared PASS, else FAIL. PASS grade is necessary to be eligible to get the degree

**Panel of Examiners shall be appointed by the concerned Head of the Department*

9. PROVISION FOR ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

9.1 If a student is not satisfied with his/her grade, the student can apply for answer book verification on payment of prescribed fee for each course within one week after announcement of results.

9.2 After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of results, which will be valued by two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is successful in the appeal by securing a better grade.

10. SUPPLEMENTARY AND SPECIAL EXAMINATIONS

10.1 The odd semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

10.2 The even semester supplementary examinations will be conducted after conducting regular odd semester examinations during October/November.

10.3 A student who has secured 'F' Grade in Project work shall have to improve his/her work and reappear for viva-voce after satisfactory completion of work approved by panel of examiners.

10.4 A student who has completed period of study and has "F" grade in final semester courses is eligible to appear for special examination.

11. MASSIVE OPEN ONLINE COURSES (MOOCs)

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses up to first semester are permitted to register for MOOCs in second semester up to a maximum of 6 credits from program elective / open elective/audit courses. However the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency will be decided by the respective Board of Studies (BoS).

12. GRADING SYSTEM

12.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

Sl.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab (Absent)	0	-

12.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5.0 for a Pass in the semester.

13. GRADE POINT AVERAGE

13.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

where, C = number of credits for the course,

G = grade points obtained by the student in the course.

13.2 The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester.

13.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for Award of Class

Class	CGPA Required
First Class with Distinction	$\geq$ 8.0*
First Class	$\geq$ 6.5
Second Class	$\geq$ 5.5
Pass Class	> 5.0

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in the first attempt.

14. ELIGIBILITY FOR AWARD OF THE M.Tech. DEGREE

14.1 Duration of the program: A student is ordinarily expected to complete the M.Tech. Program in four semesters of two years. However a student may complete the program in not more than four years including study period.

14.2 However the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

14.3 A student shall be eligible for award of the M.Tech. Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and project works.

b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated period.

c) Has no dues to the Institute, Hostels, Libraries, NCC / NSS etc, and

d) No disciplinary action is pending against him / her.

15. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

M.Tech in Power System and Automation
Department of Electrical and Electronics Engineering

(Effective from the academic year 2019-20 admitted batch)

SEMESTER I

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE701	Advanced Power System Stability	PC	3	0	0	3
2	19EEE703	Advanced Power System Protection	PC	3	0	0	3
3	19EEE7XX	Program Elective I	PE	3	0	0	3
4	19EEE7XX	Program Elective II	PE	3	0	0	3
5	19EEE7XX	Program Elective III	PE	3	0	0	3
6	19EMC741	Research Methodology and IPR	MC	2	0	0	2
7	19EEE721	Power System Steady State Analysis Laboratory	PC	0	0	4	2
8	19EEE723	Power System Protection Laboratory	PC	0	0	4	2
9	19EAC7XX	Audit Course-I	AC	2	0	0	0
Total				**21**			

SEMESTER II

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE702	EHV and UHV AC Transmission	PC	3	0	0	3
2	19EEE704	Advanced Power System Operation and Control	PC	3	0	0	3
3	19EEE7XX	Program Elective IV	PE	3	0	0	3
4	19EEE7XX	Program Elective V	PE	3	0	0	3
5	19EOE7XX	Open Elective	OE	3	0	0	3
6	19EEE722	Advanced Power system Laboratory	PC	0	0	4	2
7	19EEE724	Artificial Intelligence Laboratory	PC	0	0	4	2
8	19EAC7XX	Audit Course-II	AC	2	0	0	0
9	19EEE792	Technical Seminar	PC	0	0	4	2
Total				**21**			

SEMESTER III

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE891	Project Work I	CE	0	0	26	13
Total				**13**			

SEMESTER IV

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE892	Project Work II	CE	0	0	26	13
Total				**13**			

Total Number of Credits:

Year	Semester	Proposed Credits
I	**I**	**21**
	II	**21**
II	**III**	**13**
	IV	**13**
Total		**68**

Program Elective I

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE741	Renewable Energy Systems	PE	3	0	0	3
2	19EEE743	Smart Grids and Micro grids	PE	3	0	0	3
3	19EEE745	Power system dynamics	PE	3	0	0	3
4	19EEE747	Distribution system planning and Automation	PE	3	0	0	3

Program Elective II

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE749	Electrical Power Distribution systems	PE	3	0	0	3
2	19EEE751	Computational methods in Electrical Engineering	PE	3	0	0	3
3	19EEE753	Electric and Hybrid Vehicles	PE	3	0	0	3
4	19EEE755	Energy Auditing and Management	PE	3	0	0	3

Program Elective III

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE757	Restructured Power Systems	PE	3	0	0	3
2	19EEE759	Dynamics of Electrical Machines	PE	3	0	0	3
3	19EEE761	FACTS and Custom Power devices	PE	3	0	0	3
4	19EEE763	Engineering Optimization	PE	3	0	0	3

Program Elective IV

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE742	Artificial Intelligence Techniques	PE	3	0	0	3
2	19EEE744	Electric Power Quality	PE	3	0	0	3
3	19EEE746	Power Conversion Techniques	PE	3	0	0	3
4	19EEE748	PLC, SCADA and Automation	PE	3	0	0	3

Program Elective V

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EEE752	Power System Transients	PE	3	0	0	3
2	19EEE754	Power System Planning and Reliability	PE	3	0	0	3
3	19EEE756	Industrial Load Modelling and Control	PE	3	0	0	3

Open Elective

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EOE742	Business Analytics	OE	3	0	0	3
2	19EOE744	Industrial Safety	OE	3	0	0	3
3	19EOE746	Operations Research	OE	3	0	0	3
5	19EOE752	Waste to Energy	OE	3	0	0	3

AUDIT COURSE -1 & 2

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EAC741	English for Research Paper Writing	OE	2	0	0	0
2	19EAC742	Disaster Management	OE	2	0	0	0
3	19EAC744	Value Education	OE	2	0	0	0
4	19EAC745	Constitution of India	OE	2	0	0	0
5	19EAC746	Pedagogy Studies	OE	2	0	0	0
6	19EAC747	Stress Management by Yoga	AC	2	0	0	0

19EEE701: ADVANCED POWER SYSTEM STABILITY

L	T	P	C
3	0	0	3

Preamble: *This course leads the student into the important aspects of power system stability. Topics like modeling of synchronous machine, controller used and voltage stability are covered. Also the study of synchronous machine when connected to infinite bus, solution of swing equation by few methods is introduced.*

Course Objectives: After completion of this course the student will be able to

- Model the synchronous machine.
- Analyze the machine when connected to infinite bus.
- Identify and obtain model of the excitation controller.
- Describe the main aspects of voltage stability.
- Solve the sing equation.

Unit I **8 L**

Synchronous machine modeling: Synchronous machine, flux linkage equations. Park's transformation, per unit conversion, normalizing the equations. Equivalent circuit, current space model. Flux linkage state space model. Sub-transient and transient inductances, time constants.

Learning outcomes: After the completion of Unit I, student will be able to

- **Define** park's transformation (L1)
- **Apply** park's transformation to synchronous machine equations(L3)
- **Demonstrate** different state space models of the syn. Machine (L2)
- **Define** the reactances of the synchronous machine(L1)

Unit II **8 L**

Machine controllers: Exciter and voltage regulators, function and types of excitation systems. Typical excitation System configuration. Block diagram and state space representation of IEEE types-1, 2, 3 and 4 excitation system. Saturation function, stabilizing circuit.

Learning outcomes: After the completion of Unit II, student will be able to

- **Demonstrate** the function of exciter and voltage regulator (L2)
- **Demonstrate** the configuration of excitation system(L2)
- **Build** the state space model of different types of IEEE exciters(L3)

Unit III **8 L**

Transient stability: Assumptions for transient stability. Derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system, solution of swing equation by Euler and Runge- kutta method.

Learning outcomes: After the completion of Unit III, student will be able to

- **List** the assumptions taken in transient stability studies(L1)
- **Develop** the swing equation of SMIB system(L3)
- **Solve** the swing equation using Euler and RK methods(L5)

Unit IV **8 L**

Analysis of Single Machine System: Small signal analysis with block diagram representation. Characteristic equation and application of RH criterion. Synchronizing and damping torque analysis. Small signal model: State equations. Non linear oscillations-Hopf bifurcation.

Learning outcomes: After the completion of Unit IV, student will be able to

- **Analyze** the small signal model of SMIB system (L4)
- **Apply** the RH criterion to SMIB system(L3)
- **Illustrate** Hopf-bifurcation(L2)

Unit V **10 L**

Voltage stability: Introduction to voltage stability, factors affecting voltage instability and collapse. Comparison of angle and voltage stability. Analysis of voltage instability and collapse. Integrated analysis of voltage and angle stability. Control of voltage instability.

Learning outcomes: After the completion of Unit V, student will be able to

- **Define** voltage instability and collapse (L1)
- **List** the factors affecting the voltage instability and collapse (L1)
- **Differentiate** between angle and voltage stability(L4)
- **Analyze** the voltage and angle stability(Level I(L4)

Text Book(s)

1. P. M. Anderson, A.A Fouad, "Power System Control and Stability", 2/e, John Wiley and Sons, 2008.
2. Kundur, "Power System Stability and Control", Tata McGraw-Hill, 2013.

References

1. K R Padiyar, "Power System Dynamics",2/e, BS Publications India,2008.
2. M.A.Pai and W.Sauer, "Power System Dynamics and Stability", 7/e, Pearson Education India, 2007.

Course Outcomes:

Upon completion of the course, the students would be able to

- **Perform** Synchronous machine modeling (L3).
- **Demonstrate** and build the state space model of different types of IEEE exciters (L2).
- **Develop** the swing equation of SMIB system (L3).
- **Apply** the RH criterion to SMIB system (L3).
- **Differentiate** between angle and voltage stability and factors affecting the voltage instability and collapse (L4).

19EEE703: ADVANCED POWER SYSTEM PROTECTION

L	T	P	C
3	0	0	3

Preamble

In this course students are aimed to introduce about different digital protection algorithms and implementation of algorithms using microprocessor.

Course Objectives:

The purpose of the course is to

- **Recall** the various Electromagnetic and static relays.
- **Outline** the Input quantities for various types of distance relays.
- **Select** the switching schemes for reduction in measuring devices.
- **Explain** the importance of digital protection algorithms.
- **Use** the microprocessor for implementation of digital protection algorithms.

Unit I **8 L**

Introduction to Protective Relays: Current transformers for protection, Coupling capacitor voltage transformers, transient performance of current transformer, CCVT potential transformer, review of electromagnetic relays static relays. Over current relays-time current characteristic, current setting time setting, directional relay, static over current relays.

Learning Outcomes:

After completion of Unit I, student will be able to

- **List** the different electromagnetic and static relays(L1)
- **Interpret** characteristics of Photovoltaic cells (L2)
- **Identify** current setting time setting of relays(L3)
- **Analyze** transient performance of current transformer (L4)

Unit II **8 L**

Distance protection-I: Impedance, reactance, mho, angle impedance relays, Input quantities for various types of distance relays, effect of arc resistance on the performance of distance relays, selection of distance relays, MHO relay with blinders, quadrilateral relay, elliptical relay, Restricted mho, impedance directional, reactance relays, Swiveling characteristics.

Learning Outcomes:

After completion of Unit II, student will be able to

- **List** Input quantities for various types of distance relays (L1)
- **Explain** effect of arc resistance on the performance of distance relays (L1)
- **Select** the distance relays for transmission lines protection(L3)
- **Interpret** Swiveling characteristics (L4)

Unit III **8 L**

Distance protection-II : Compensation for correct distance measurement, reduction of measuring units, switched schemes, Pilot relaying schemes, Wire pilot protection, circulating current scheme, balanced voltage scheme, transley scheme, carrier current protection, phase comparison carrier current protection, carrier aided distance protection.

Learning outcomes:

After completion of Unit III, student will be able to

- **Select** Compensation for correct distance measurement (L1)
- **Explain** switched schemes for measuring units(L2)
- **Outline** Pilot relaying schemes (L2)
- **Apprise** carrier aided distance protection (L5)

Unit IV **8 L**

Digital relaying techniques: Digital relaying algorithms, differential equation technique, discrete Fourier transform technique, Walsh-Hadamard transform technique, rationalized Haar transform technique, removal of dc offset.

Learning outcomes:

After completion of Unit IV, student will be able to

- **Demonstrate** digital relaying algorithms (L2)
- **Develop** various digital relaying algorithms (L2)
- **Compare** various digital relaying algorithms (L4)
- **Make use of** removal of dc offset (L5)

Unit V **10 L**

Microprocessor based protective relays: Over current, directional, impedance, reactance relays, generalized mathematical expressions for distance relays, mho and offset mho relays, quadrilateral relay, Microprocessor implementation of digital distance relaying algorithms.

Learning outcomes:

After completion of Unit V, student will be able to

- **Interpret** microprocessor based relays (L2)
- **Develop** generalized mathematical expressions for distance relays(L2)
- **Contrast** various digital relaying algorithms using microprocessor(L4)
- **Make use of** microprocessor for implementation of digital relaying algorithms(L5)

Text Book(s):

1.Badri Ram, Power System Protection and Switchgear, 3/e, Tata McGraw-Hill Education, 2011.
2.Madhava Rao, Power System Protection: Static Relays with microprocessor Applications, 2/e, Tata McGraw-Hill Education, 2004.

References:

1.BhaveshBhalja,Maheshwari,,NileshChothani, Protection and Switchgear, illustrated, reprint Edition, Oxford University Press India, 2011.

Course Outcomes:

Upon completion of the course, the student would be able to

- **Define** various Electromagnetic and static relays (L1).
- **Outline** various types of distance relays (L2).
- **Estimate** compensation for correct distance measurement (L6).
- **Develop** various digital relaying algorithms (L3).
- **Experiment** with microprocessor in implementation of digital relaying algorithms (L3).

19EEE741: RENEWABLE ENERGY SYSTEMS
(Elective)

L	T	P	C
3	0	0	3

Preamble
In this course it is aimed to introduce to the students the basic principles of Solar and Wind power systems. The basic concepts of solar energy resource, wind statistics and wind driven induction generators are explained. The basic equations of machine modeling parameters are analyzed.

Course Objectives:
The purpose of the course is to
- **Study** of various fundamentals of photovoltaic cell and characteristics.
- **Expose** various basic concepts of wind turbines.
- **Familiarize** various parameters in induction generators.
- **Expose** about grid integration issues in integrated wind-solar systems
- **Interpret** the feasibility of micro-hydel electric systems.

Unit I: Solar Energy **8 L**
Basic characteristics of sunlight – solar energy resource – photovoltaic cell-characteristics – equivalent circuit – photo voltaic for battery charging.

Learning outcomes:
After completion of Unit I, student will be able to
- **Define** the basic characteristics of Sunlight (L1)
- **Contrast** the difference between direct radiation and diffuse radiation(L2)
- **Identify** the different ways to generate power from solar (L3)
- **Analyze** characteristics of Photovoltaic cells (L4)
- **Justify** the use of PV cells over conventional power sources. (L5)

Unit II: Basics of Wind Energy **8 L**
Wind source – wind statistics - energy in the wind – aerodynamics - rotor types – forces developed by blades-Aerodynamic models – braking systems – tower - control and monitoring system – power performance

Learning outcomes:
After completion of Unit II, students will be able to
- **Define** the basic characteristics of wind source (L1)
- **Demonstrate** the calculations of wind statistics(L2)
- **Develop** the equations for forces developed in different parts of turbine (L3)
- **Survey** wind availabilities based on different methodologies (L4)
- **Appraise** the performance of the wind power plant. (L5)

Unit III: Wind driven Induction Generator **8 L**
Wind driven induction generators-power circle diagram-steady state performance –modeling-integration issues –impact on central generation- transmission and distribution systems – wind farm electrical design.

Learning outcomes:
After completion of Unit III, students will be able to
- **List** the various AC generators used in Wind power(L1)
- **Develop** power circle diagram of induction generator(L3)
- **Analyze** steady state modeling of induction generators (L4)

- **Evaluate** integration issues in wind power (L5)
- **Design** wind farms. (L6)

Unit IV: Hybrid Combinations of Wind energy **8L**

Wind-diesel systems-fuel savings-permanent magnet alternators – modeling – steady state equivalent circuit-self-excited induction generators – integrated wind-solar systems.

Learning outcomes:

After completion of Unit IV, student will be able to

- **Relate** wind diesel systems(L1)
- **Illustrate** various penetration factors in wind-diesel systems (L2)
- **Analyze** steady state modeling of synchronous generators (L4)
- **Interpret** integrated solar-wind systems(L5)
- **Formulate** the levels of penetration in integratedsolar-wind systems. (L6)

Unit V: Micro-hydel electric systems **8L**

Micro-hydel electric systems – power potential – scheme layout – generation efficiency and turbine part flow-isolated and parallel operation of generators.

Learning outcomes:

After completion of UNITV, students will be able to

- **List** out various types of hydro power plants (L1)
- **Demonstrate** power potential in micro hydel system(L2)
- **Distinguish** different turbines in micro hydel power systems(L4)
- **Justify** the use of micro-hydel electric systems (L5)
- **Elaborate** parallel operation of generators. (L6)

Text Book(s):

1. J.N.Twidell&A.D.Weir-Renewable Energy Sources, University press,Cambridge, 2001
2. Sukhatme, S.P., Solar Energy -Principles of Thermal Collection and Storage, Tata McGraw- Hill, New Delhi 1997.

References:

1. Kreith, F., and Kreider, J.F., Principles of Solar Engineering, Mc-Graw-Hill Book Co. 2000.
2. James Larminie , Andrew Dicks , Fuel Cell Systems, John Weily& Sons Ltd, 2000
3. J. F. Manwell , J. G. McGowan, A. L. Rogers , Wind Energy Explained, John Weily& Sons Ltd 2009
4. G.D. Rai, “Non Conventional energy Sources”, Khanna Publications ,New Delhi.1994

Course Outcomes:

Upon completion of the course, the students would be able to

- **Relate** various fundamentals of solar and wind energy systems (L2).
- **Identify** various basic concepts of machine modeling (L3).
- **Estimate** various parameters in wind statistics (L6).
- **Analyze** about integration of wind, solar and diesel energy systems (L4).
- **Appraise** the micro-hydel power systems (L5).

19EEE743: SMART GRIDS AND MICRO GRIDS
(Elective)

L	T	P	C
3	0	0	3

Preamble

The course discusses the international and national development towards the future's renewable electric energy system, and the concept known as Smart Grid. The starting point is the understanding of how design, operation and control of power systems traditionally have been considered. Power systems, power electronics and renewable energy merge, for example in micro grids. In addition, the course discusses the interaction between the power grid and flexible resources, and smart meters.

Course Objectives:
The purpose of the course is to

- Develop more understanding on the concepts of Smart Grid and its present developments.
- Explain about different Smart Grid technologies.
- Build knowledge about different smart meters.
- Build knowledge on power quality management in Smart Grids.
- Have knowledge about technology for micro grids and integration of renewable energy and energy storage.
- Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid application.

Unit I **8 L**

Introduction to Smart Grid: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

Learning outcomes:
After completion of Unit I, students will be able to

- **Explain** about different Smart Grid technologies.(L2)
- **Develop** different smart grid drivers .(L3)
- **Distinguish** conventional & Smart Grid in detail .(L4)

Unit II **8 L**

Smart Grid Technologies (Transmission): Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

Learning outcomes:
After completion of Unit II, students will be able to

- **Explain** concepts of smart grid and various issues related to smart grid technology deployment (L2)
- **Analyze** different technology drivers available in smart grid (L4)
- **Combine** different smart energy resources.(L6)

Unit III **8 L**

Smart Grid Technologies (Distribution) :DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV)

Learning outcomes:
After completion of Unit III, students will be able to

- **Relate** key technologies in distribution systems that enable smart grid(L2)

- **Explain** about phase shifting and high efficiency distribution Transformers (L5)
- **Demonstrate** importance of Plug in Hybrid Electric Vehicles(L2)

Unit IV **8 L**

Smart Meters and Advanced Metering Infrastructure and High Performance Computing: Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives and AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) ,Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN),Broadband over Power line (BPL), IP based Protocols

Learning outcomes:

After completion of MODULE IV, students will be able to

- **outline** about different challenges and possibilities related to smart meters (L2)
- **Solve** Cyber Security problems for Smart Grid (L6)
- **Explain** about IP based Protocols (L4)

Unit V **10 L**

Micro Grids: Concept and definition of micro grid, micro grid drivers and benefits, review of sources of micro grids, typical structure and configuration of a micro grid, AC and DC micro grids, Power Electronics interfaces in DC and AC micro grids, communication infrastructure.

Learning outcomes:

After completion of MODULE V, students will be able to

- **Apply** concepts of micro grid. (L3)
- **Examine** interfaces in DC and AC micro grids. (L4)
- **Explain** about communication infrastructure used in Micro Grid (L4)

Text Book(s)

1. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press 2012.

References

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.2012

Course outcomes:

- **Explain** about different Smart Grid technologies (L2).
- **Relate** key technologies in distribution systems that enable smart grid (L2).
- **Solve** Cyber Security problems for Smart Grid (L6).
- **Examine** interfaces in DC and AC micro grids (L4).
- **Explain** about IP based Protocols (L4).

19EEE745: POWER SYSTEM DYNAMICS
(Elective)

L	T	P	C
3	0	0	3

Preamble: *This course leads the student into the concepts of power system Dynamic and Transient stability. Modeling of synchronous machine, controller used and voltage stability are covered. Models of machine including exciters and the solution of the model equations are studied. Also different linear models of the synchronous machine for dynamic stability are covered.*

Course Objectives: After the completion of this course the student will be able to

- **Model** the synchronous machine.
- **Identify** and obtain model of the excitation controller.
- **Describe** the aspects of transient stability.
- **Solve** the linear models of the synchronous machine

Unit I **10L**

Concept and importance of stability in power system operation and design: Distinction between transient and dynamic stability, complexity of stability problem in large system, need for reduced models, stability of interconnected systems.

Learning outcomes: After the completion of Unit I, the student will be able to

- **Define** transient and dynamic stability (L1)
- **Distinguish** between dynamic and transient stability(L4)
- **Analyze** the complexity of stability of big system(L4)

Unit II **8L**

Machine modeling: Park's transformation, flux linkage equations, current space model, per unit conversion, normalizing the equations , equivalent circuit, flux linkage state space model, simplified models (one axis and constant flux linkage), steady state equations and phasor diagrams.

Learning outcomes: After the completion of Unit II, the student will be able to

- **Define** park's transformation (L1)
- **Apply** park's transformation to synchronous machine equations.(L3)
- **Demonstrate** different state space models of the syn. Machine (L2)
- **Define** the reactance's of the synchronous machine(L1)

Unit III **8L**

Machine controllers: Exciter and voltage regulators, function of excitation systems, types of excitation systems, typical excitation system configuration, block diagram and state space representation of IEEE type 1 excitation system, saturation function, stabilizing circuit, function of speed governing systems, block diagram and state space representation of IEEE mechanical hydraulic governor and electrical hydraulic governors for hydro turbines and steam turbines.

Learning outcomes: After the completion of Unit III, the student will be able to

- **Define** the function of exciter and voltage regulator (L1)
- **Demonstrate** the configuration of excitation system(L2)
- **Develop** the state space model of different types of IEEE exciters(L3)

Unit IV **8L**

Transient stability: State equation for multi machine simulation with one axis model, transient stability simulation of multi machine power system with one axis machine model including excitation system and speed governing system using R-K method of fourth order (Gill's technique), power system stabilizer.

Learning outcomes: After the completion of Unit IV, the student will be able to

- **Define** the state equations of multi machine system (L1)
- **Solve** the one and two axes models of multi machine system (L1)
- **Define** the function of power system stabilizer(L1)

Unit V **8L**

Dynamic stability: System response to small disturbances, linear model of the unregulated synchronous machine and its modes of oscillation, regulated synchronous machine, distribution of power impact, linearization of the load equation for the one machine problem, simplified linear model, effect of excitation on dynamic stability, approximate system representation, supplementary stabilizing signals, dynamic performance measure, small signal performance measures.

Learning outcomes: After the completion of Unit V, the student will be able to

- **Define** the response of linear models for small disturbances(L1)
- **Define** the oscillations of system(L1)
- **Define** the effect of excitation on dynamic stability(L1)
- **Develop** the approximate system model(L3)
- **List** the measures that indicate the performance of small signal model(L1)

Text Book(s)

1. Kundur.P, Power System Stability and Control, McGrawHill, 1994.
2. Anderson.P.M and Fouad.A.A, Power System Control and Stability, 2/e, Galgotia, Publications, 2003.

References

1. M.A Pai and Sauer.W, Power System Dynamics and Stability, 2/e, Pearson Education, 2006.

Course Outcomes:

Upon completion of the course, the student would be able to

- **Explain t**he importance of stability in power system operation and design (L5).
- **Apply** park's transformation to synchronous machine equations (L3).
- **Develop** the state equations of multi machine system and (L6).
- **Explain** function and design of power system stabilizer (L2).
- **Explain** the effect of excitation on dynamic stability (L2).

19EEE747: DISTRIBUTION SYSTEM PLANNING AND AUTOMATION
(Elective)

L	T	P	C
3	0	0	3

Preamble
This course is aimed to introduce to the students about basic concepts of distribution system planning and automation. Basics of load characteristics, distribution transformers, Primary systems, capacitors in distribution system and distribution system automation. Pragmatic principles in automation are learned with real time basis.

Course Objectives:
The purpose of the course is to
- **Study** of various fundamentals of distribution system planning & automation.
- **Exemplify** basic concepts of load characteristics in distribution systems.
- **Familiarize** various distribution transformers.
- **Expose** about selection capacitors in distribution systems
- **Interpret** the feasibility of reforms in power sector.

Unit I: **8 L**
Load Characteristics: Definitions – Load forecasting – methods of forecast – regression analysis – correlation analysis and time series analysis – Load management – tariffs and metering of energy.

Learning Outcomes:
After completion of Unit I, students will be able to
- **Define** the basic characteristics of load forecasting (L1)
- **Contrast** the difference between correlation analysis and time series analysis (L2)
- **Identify** the different ways of load management (L3)
- **Analyze** regression methods (L4)
- **Justify** the use of tariffs and metering of energy. (L5)

Unit II: **8 L**
Distribution Transformers: Types – Three phase and single-phase transformers – connections – Dry type and self-protected type transformers – regulation and efficiency.

Learning outcomes:
After completion of Unit II, students will be able to
- **List** out types of distribution transformers (L1)
- **Compare** three phase and single-phase transformers (L2)
- **Model** connections of dry type and self-protected type transformers (L3)
- **Inspect** regulation of distribution transformers (L4)
- **Appraise** the efficiency of distribution transformers. (L5)

Unit III: **8 L**
Primary Systems: Types of feeders – voltage levels – radial type feeders.
Voltage Drop and Power Loss Calculations: Three phase primary lines – Copper loss – Distribution feeder costs – Loss reduction and Voltage improvement in rural networks.

Learning outcomes:
After completion of Unit III, students will be able to
- **Choose** various types of feeders (L1)
- **Develop** voltage drop and power loss calculations (L3)

- **Analyze** three phase primary lines (L4)
- **Evaluate** distribution feeder costs (L5)
- **Develop** voltage improvements model in rural networks. (L6)

Unit IV: **8 L**

Capacitors In Distribution Systems: Effects of series and shunt capacitors – justification for capacitors – Procedure to determine optimum capacitor size and location.

Learning outcomes:

After completion of Unit IV, students will be able to

- **Relate** series and shunt capacitors in distribution systems (L1)
- **Illustrate** capacitors in distribution systems (L2)
- **Analyze** justification of capacitors (L4)
- **Interpret** procedure to determine optimum capacitor size and location (L5)

Unit V: **10 L**

Distribution System Automation: Reforms in power sector – Methods of improvement – Reconfiguration – Reinforcement – Automation – Communication systems – Sensors – Automation systems – Basic architecture of Distribution automation system – software and open architecture – RTU and Data communication.

Learning outcomes:

After completion of Unit V, students will be able to

- **List** out various reforms in power sector (L1)
- **Demonstrate** methods of improvement in distribution system automation (L2)
- **Distinguish** reconfiguration and reinforcement automation (L4)
- **Interpret** basic architecture of distribution automation systems (L5)
- **Elaborate** RTU and Data communication. (L6)

Text Books:

1. Turan Gonen : Electric Power Distribution Engg., Mc-Graw Hill,1986.
2. A. S. PABLA : Electric Power Distribution, TMH,2000.

References

1. Khedkar.M.K and Dhole.G.M. , A Text book of Electric Power Distribution Automation. , University Science Press, 2010

Course Outcomes:

Upon completion of the course, the students would be able to

- **Relate** various load characteristics in distribution transformer (L2).
- **Identify** various basic concepts of distribution transformers (L3).
- **Estimate** various parameters in primary systems (L6).
- **Analyze** optimal capacitor size and location in distribution transformer (L4).
- **Appraise** distribution system automation. (L5).

19EEE749: ELECTRICAL POWER DISTRI BUTION SYSTEMS
(Elective)

L	T	P	C
3	0	0	3

Preamble
In this course it is aimed to introduce to the students about basic principles distribution systems. The basic concepts of design in distribution feeders, System analysis and Capacitive compensation, are explained. The basic Operation and coordination of electrical power distribution systems are analyzed.

Course Objectives:
The purpose of the course is to
- Study of various fundamentals of distribution systems and characteristics.
- Expose to various basic concepts of substations design.
- Familiarize various parameters in induction generators.
- Expose about power factor correction with a capacitor.
- Interpret the feasibility of design operation and coordination.

Unit I **10 L**

Introduction to distribution systems: Over view of distribution systems. Load modeling and characteristics. Coincidence factor, contribution factor loss factor. Relationship between the load factor and loss factor. Classification of loads (residential, commercial, agricultural and industrial) and their characteristics.

Learning outcomes:
After completion of Unit I, students will be able to
- **Define** the basic characteristics of load modelling in distribution systems (L1)
- **Contrast** the difference between coincidence factor and contribution factor. (L2)
- **Identify** the different ways of load factor and loss factor (L3)
- **Analyze** characteristics of various loads (L4)
- **Justify** different loads with their characteristics. (L5)

Unit II **8 L**

Design considerations of distribution feeder: Basic design practice of the secondary distribution system. Location of Substations: Rating of distribution substation, service area within primary feeders. Benefits derived through optimal location of substations.

Learning outcomes:
After completion of Unit II, students will be able to
- **Define** the basic characteristics of secondary distribution systems (L1)
- **Demonstrate** the calculations of locations of substations. (L2)
- **Develop** the equations for ratings of substation. (L3)
- **Survey** service area with primary feeders (L4)
- **Appraise** optimal location of substation. (L5)

Unit III **8 L**

System analysis: Voltage drop and power loss calculations: derivation for voltage drop and power loss in line, distribution automation. Energy management, load management. Limitations of distribution systems. Improvement of existing distribution system, fault locations, future orientation of rural system.

Learning outcomes:
After completion of Unit III, students will be able to

- **Show** derivations of voltage drop and power loss calculations (L1)
- **Model** distribution automation. (L3)
- **Analyze** load management and limitations. (L4)
- **Design** improvement of distribution systems. (L6)
- **Evaluate** future orientation of rural system (L5)

Unit IV **8 L**

Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors, effect of series capacitors. Power factor correction, capacitor allocation. Economic justification. Procedure to determine the best capacitor location.

Learning outcomes:
After completion of Unit IV, students will be able to
- **Relate** shunt and series power factor correction (L1)
- **Illustrate** different types of power capacitors (L2)
- **Analyze** power factor correction with capacitor allocation (L4)
- **Interpret** economic justification in presence of capacitors (L5)
- **Formulate** the best capacitor location procedure. (L6)

Unit V **8 L**

Design, operation and coordination: Load variation, voltage fluctuations, Motor starting, simultaneous operation. Continuous varying loads, measure to reduce flickering. Coordination of protective devices: general coordination procedure.

Learning outcomes:
After completion of Unit V, students will be able to
- **List** out load variations (L1)
- **Demonstrate** simultaneous operation (L2)
- **Distinguish** different continuous varying loads (L4)
- **Justify** the measure to reduce flickering (L5)
- **Elaborate** general coordination procedure. (L6)

Text Book(s)

1. Turan Gonen, Electric Power Distribution System, Engineering, 4/e, McGrawHill , 1985.
2. A.S.Pabla, Electric Power Distribution, 4/e, Tata McGrawHill, 1997.

References

1. S.Sivanagaraju, V.Sankar, Electrical Power Distribution and Automation, DhanpatRai and Co, 2006.
2. V.Kamaraju , Electrical Power Distribution systems, 3/e, Right publishers, 2009.

Course Outcomes:

Upon completion of the course, the students would be able to

- **Relate** various fundamentals of distribution systems (L2).
- **Identify** optimal location of substations. (L3)
- **Estimate** energy management for improvement of existing system (L6)
- **Analyze** power factor correction with capacitors(L4)
- **Appraise** simultaneous operation and coordination. (L5)

19EEE751: COMPUTATIONAL METHODS IN ELECTRICAL ENGINEEERING

(Elective)

L	T	P	C
3	0	0	3

Preamble

In this course it is aimed to introduce to the students the basic principles of computational methods in Electrical power systems. The basic concepts of graph theory, fault analysis& power system optimization explained.

Course Objectives:

The purpose of the course is to

- Study of various fundamentals of Graph Theory.
- Expose various basic concepts of fault analysis.
- Familiarize various problems in power system optimization.
- Expose about Generation with Limited Energy Supply
- Interpret the Power system security concepts.

Unit I **10L**

GraphTheory: Systemgraph.Loop,cutestandincidencematrices.Gauss method. Decoupled method. DC power flow. Sparsity. AC, DC load flow analysis.

Learning outcomes:

After completion of UNITI, students will be able to

- **Define**the basic terms in graph theory(L1)
- **Contrast** the difference between AC power flow & DC power flow(L2)
- **Identify** the different load flow methods (L3)
- **Analyze**characteristics sparsity (L4)
- **Justify** the AC, DC load flow analysis.. (L5)

Unit II **8L**

Fault analysis: Three phase short circuit of an alternator. Numerical examples on fault limiting reactors. Fault calculations using admittance matrix.

Learning outcomes:

After completion of UNITII, students will be able to

- **Define** the basic characteristics of fault(L1)
- **Demonstrate** the calculations of different faults (L2)
- **Develop** the equations for fault calculations (L3)
- **Analyze** Three phase short circuit of an alternator(L4)
- **Justify** Fault calculations using admittance matrix. (L5)

Unit III **8L**

Power system optimization: Unit commitment: Problems solving on priority list. Dynamic programming method. Optimal scheduling of hydrothermal system.

Learning outcomes:
After completion of UNITIII, students will be able to

- **List** the power system optimization problems (L1)
- **Develop** algorithms for unit commitment (L3)
- **Analyze** Problems solving on priority list(L4)
- **Evaluate** Dynamic programming method(L5)
- **Design** Optimal scheduling of hydrothermal system. (L6)

Unit IV **8L**

Generation with Limited Energy Supply: Introduction, take or pay fuel supplycontract.Compositegenerationproduction.Costfunction,solution by gradient search techniques.

Learning outcomes:
After completion of UNITIV, students will be able to

- **Define** Generation with Limited Energy Supply(L1)
- **Illustrate** take or pay fuel supply contract(L2)
- **Analyze** Composite generation production(L4)
- **Interpret** Cost function(L5)
- **Formulate** the solution by gradient search techniques. (L6)

UnitV **8L**

Power system security: Factors affecting security. State transition diagram. Contingency analysis using network sensitivity method and AC power flow method.

Learning outcomes:
After completion of UNITV, students will be able to

- **List** out various Factors affecting security(L1)
- **Demonstrate** State transition diagram(L2)
- **Analyze** Contingency analysis using network sensitivity method (L4)
- **Justify** the AC, DC load flow analysis..(L5)
- **Elaborate** AC power flow method. (L6)

Text Book(s)

1.I.J. Nagarath, D.P. Kothari, Power System Engineering , 3/e, Tata McGraw Hill,2009.

References

1. A.J. Wood, B.F. Wollenberg, Power Generation Operation and Control, 2/e,JohnWiley&Sons,1994.

2. O.I. Elgard, Electric Energy System Theory: An Introduction, 2/e, McGrawHill,1996.

3. HadiA.Saadat,PowerSystemAnalysis,2/e,McGrawHill,2002.

Course Outcomes:
Upon completion of the course, the students would be able to

- **Relate** various fundamentals of Graph Theory (L2).
- **Identify** various basic concepts of fault analysis (L3).
- **Estimate** various problems in power system optimization(L6)
- **Assess** about integration of wind, solar and diesel energy systems(L5)
- **Appraise** the Power system security concepts (L5).

19EEE753: ELECTRIC AND HYBRID VEHICLES
(Elective)

L	T	P	C
3	0	0	3

Preamble
In this course it is aimed to introduce to the students the basic principles of Electric and Hybrid Vehicles. The basic concepts of Hybrid Electric Vehicles, conventional Vehicles and Hybrid Electric Drive-Trains are explained. The basic equations of mathematical modeling parameters are analyzed.

Course Objectives:
The purpose of the course is to
- Study of various fundamentals of vehicle performance and characteristics.
- Expose various basic concepts of Hybrid Electric Drive-Train.
- Familiarize various electric propulsion unit.
- Expose about energy storage
- Interpret the energy management strategies.

Module 1: Basic concepts of Hybrid Electric Vehicles 8 L
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Learning outcomes:
After completion of UNIT I, students will be able to
- **Define** the basic concepts of Electric vehicles(L1)
- **Demonstrate** the history of hybrid and electric vehicles (L2)
- **Identify** the Importance of hybrid and electric vehicles (L3)
- **Analyze** the social and environmental importance of hybrid and electric vehicles (L4)
- **Justify** the impact of modern drive trains on energy supplies. (L5)

Module 2: Conventional Vehicles & Hybrid Electric Drive-Trains 8 L
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Learning outcomes:
After completion of UNIT II, students will be able to
- **Define** the Basics of vehicle performance(L1)
- **Demonstrate** the vehicle power source characterization(L2)
- **Develop** The mathematical models (L3)
- **Survey** Basic concept of hybrid traction(L4)
- **Appraise** the fuel efficiency analysis. (L5)

Module 3: Electric Propulsion Unit 8 L
Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Learning outcomes:
After completion of UNIT III, students will be able to

- **List** the electric components used in hybrid and electric vehicles(L1)
- **Develop** Configuration and control of DC Motor drives(L3)
- **Analyze** Configuration and control of Induction Motor drives(L4)
- **Evaluate** drive system efficiency(L5)
- **Design** configuration and control of Permanent Magnet Motor drives. (L6)

Module 4: Energy Storage **8 L**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Learning outcomes:

After completion of UNIT IV, students will be able to

- **Relate** Energy Storage Requirements in Hybrid and Electric Vehicles(L1)
- **Illustrate** Battery based energy storage and its analysis(L2)
- **Analyze** Fuel Cell based energy storage and its analysis(L4)
- **Interpret** Flywheel based energy storage and its analysis(L5)
- **Formulate** the Hybridization of different energy storage devices. (L6)

Module 5: Energy Management Strategies **10 L**

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Learning outcomes:

After completion of UNIT V, students will be able to

- **List** out energy management strategies used in hybrid and electric vehicles(L1)
- **Demonstrate** classification of different energy management strategies(L2)
- **Distinguish** comparison of different energy management strategies(L4)
- **Justify** the energy management strategies (L5)
- **Elaborate** implementation issues of energy management strategies. (L6)

Text Book(s):

1. Chrismi, M. AbulMasrur and David WenzhangGao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley, 2011.
2. Yang Sheng Xu, HuihuanQian, Jingyu Yan and Tin Cun Lam, Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids, IET, 2014.

References:

1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.

Course Outcomes:
Upon completion of the course, the students would be able to

- **Correlate** various fundamentals of hybrid and electric vehicles (L2).
- **Identify** various basic concepts of machine modeling (L3).
- **Estimate** various parameters in hybrid and electric vehicles (L6).
- **Assess** about integration of hybrid and electric vehicles (L5).
- **Appraise** the hybrid and electric vehicles (L5).

19EMC741: RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

This course introduces the student, to the fundamentals of research, research process, technical writing and intellectual property rights. Students will be able to use this knowledge to gain interest in their subject area and pursue their career in research.

Course Objectives

- To familiarize the meaning, objectives and sources of research
- To acquaint the student with the importance and methods of literature review/research ethics
- To impart the knowledge of technical writing for preparing reports, presentations, research proposals, conference/journal publications
- To introduce the terminology and process of obtaining intellectual property rights
- To expose the intricacies in the process of obtaining patent rights

Unit I **5L**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning of a research problem (L1)
- list the different sources of research problem (L2)
- enumerate the different criteria of good research and list the different errors in selecting research problem (L2)
- contrast the different approaches of research (L3)
- compare the different methods for data collection and analysis (L5)

Unit II **5L**

Effective literature studies approaches, analysis Plagiarism, Research ethics

Learning Outcomes

After the completion of this unit, the student will be able to

- list and elaborate the different steps of the research process (L1)
- explain the importance of carrying out an effective literature review (L2)
- identify the research gaps from literature review (L5)
- describe the ethical principles to be following during research process and authorship (L2)
- define the terminology and list the methods to avoid being accused of plagiarism (L1)
- list the different types of research misconduct (L2)

Unit III **5L**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Learning Outcomes

After the completion of this unit, the student will be able to

- list the attributes, reasons and guidelines for effective technical writing (L1)
- contrast between conference paper, technical presentation and journal paper (L3)
- choose a particular research contribution for patenting or journal publication (L4)
- describe the terminology related to citation, citation index, h-index etc (L2)

Unit IV **5L**

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. **International Scenario**: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the codes and standards in building intellectual property rights(L2)
- list the subject, importance and requirements for of patentability(L1)
- explain the process of patenting and commercialization in academia(L2)
- enumerate the procedure for application preparation, filing and grant of Patents(L2)

Unit V **8L**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR**: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the scope of patent rights(L2)
- describe the process for licensing and transfer of technology(L2)
- identify the sources of patent information and databases(L1)
- elaborate the administration of patent system(L2)
- describe the new developments in IPR in computer software, biological systems etc(L3)

Text Book(s):

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for Science and engineering students", Tata Mcgraw Hill India, 2013.
2. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 2/e, Prentice Hall of India, 2013.

References:

1. Halbert, “Resisting Intellectual Property”, Taylor and Francis Limited, 2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publishers, 2008

Course Outcomes

After successful completion of the course, the student will be able to

- define the meaning, sources, approaches for research problems (L1)
- explain the guidelines for carrying out effective literature review and identify research gaps(L2)
- describe effective guidelines for preparing technical reports, research publications, presentations and research proposals(L2)
- describe the codes, standards and process of obtaining intellectual property rights(L3)
- enumerate the new developments of IPR in engineering systems(L3)

19EEE721: POWER SYSTEMS STEADY STATE ANALYSIS LAB

L	T	P	C
0	0	4	2

Preamble

In this course it is aimed to introduce to the students the different stability analysis software's.

Course Objectives:

The purpose of the course is to

- Studyof various softwares like MATLAB, MiPower, Etap and PSCAD.
- Expose various basic concepts of different converters.
- Familiarizeprogramming skills in implementing the different circuits.
- Exposeabout issues in various circuits.
- Interpret the feasibility of circuits in different applications.

List of Programs:

1. Develop a 120^{o} conduction made 3Φ converter circuit using Thyristors –MATLAB simulink
2. Develop a model for 30 convertor circuit using Thyristors – MATLAB Simulink
3. Write a program for obtaining bus voltages in a 4 bus systems using Gauss- siedel method – MATLAB Programming
4. Write a program for obtaining bus voltages of a 4 bus system using Newton Raphson method – MATLAB Programming.
5. Develop a model of 4 bus system and calculate the bus voltages using Fast decoupled method – Mi power Software
6. Develop a model of 5 bus system and calculate the bus voltages using Gauss -Siedel& Newton Raphson methods – MiPower Software.
7. Develop a model to calculate the fault currents in a systems (Symmetrical faults) – PSCAD Software
8. Develop a model to calculate the fault current s in a systems (Un symmextical faults) – PSCAD Software
9. Write a program for obtaining unit commitment using priority list method – MATLAB Programming
10. Develop a model of 5 bus system and note down the effects of wind power and solar power when they are integrated. Do the load flow analysis and short circuit analysis for the system – MiPower / ETAP Software

Learning outcomes:

After completion, students will be able to

- **Study** the basic circuits.(L1)
- **Contrast** the difference between each circuits with each software (L2)
- **Identify** the different ways to implement the methods (L3)
- **Analyze** different circuits using different software's(L4)
- **Justify** the use of various methods. (L5)

19EEE723 :POWER SYSTEM PROTECTION LABORATORY

L	T	P	C
0	0	4	2

Course Objectives:

The purpose of the course is to

- Study the of various Insulators and relays
- Demonstrate the fusing element behavior at different conditions.
- Analyze the characteristics of different relays.
- Expose Transmission line model and its parameters.
- Recommend the suitable line lengths for different applications.

Minimum of TEN experiments to be conducted from the following:

1. Study of Different Types of Insulators
2. Study of Different Types of Relays
3. Time-Current Characteristics of Fuse
4. Static Over Voltage Relay
5. Static Under Voltage Relay
6. Time-Current Characteristics Of Over Current Relay
7. Operating Characteristics of Biased Differential Relay
8. Earth Resistance Measurement
9. Transmission Line Parameters
10. Ferranti Effect Of Transmission Line
11. Transmission Line Efficiency for Different Loads
12. Power Flow In A Both End Fed Transmission Line
    a)Noload With Phase Shift In Injected Voltage
    b)Mid Tapped Load
13. Transmission Line Voltage Regulation for Different Loads
14. Transmission Line Reactive Power Compensation With no-load
15. Enhancing The Power Flow Of Transmission Line Series Compensation
16. 3-Zone Protection of Transmission Line Using Distance Relay.

Learning outcomes:

After completion, students will be able to

- **Name** the parts of different insulators and relays.(L1)
- **Identify** the suitable fusing elements to various applications (L3)
- **Modify** the operational time and current magnitude of the relays(L6)
- **Analyze** performance of different transmission lines(L4)
- **Judge** the suitable line length for different applications(L5)

19EEE702: EHV & UHV AC Transmission

L	T	P	C
3	0	0	3

Preamble

This course introduces the concepts of extra high voltage AC transmission. It also emphasis on the behavior of the line parameters for extra high voltages and Ultra high voltages, voltage gradients of the transmission line conductors gradients, the effect of corona, electrostatic filed calculations, travelling wave theory concept, voltage control when the line carries extra high voltages.

Course Objectives:

The purpose of the course is to

- Provide In-depth understanding of different aspects of Extra High Voltage AC transmission system design and Analysis.
- Understand the concept of Voltage gradients of conductors.
- Develop the empirical formula to determine the Corona loss occurring in EHV AC transmission Line.
- Determine the interference caused by Corona and to measure its magnitude.
- Understand the concept of UHV AC Transmission system.

Unit I **8 L**

Introduction to E.H.V. A.C: Role of EHVAC transmission: transmission line trends and preliminary aspects standard transmission voltages, power handling capacities and line losses, mechanical aspects.

Learning outcomes:

After completion of UNIT I, students will be able to

- **Explain** about different EHVAC transmission line trends.(L2)
- **Analyze** different standard transmission voltages.(L4)
- **Distinguish** various power handling capacities and line losses.(L4)

Unit II **8 L**

Calculation of line parameters: Resistance, inductances and capacitance, resistance of conductors, temperature rise of conductor and current carrying capacity, inductance of two conductor lines and multi–conductor lines. Line capacitance calculation: capacitance of two conductor lines, capacitance of multi conductor lines, mechanical design of towers, sag-tension calculations

Learning outcomes:

After completion of UNIT II, students will be able to

- **Explain** concepts of Resistance, inductances and capacitance of conductors. (L2)
- **Analyze** multi conductor lines parameters.(L4)
- **Explain** about mechanical design of towers, sag-tension calculations. (L5)

Unit III **8 L**

Voltage Gradient on conductors: Surface voltage gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than three sub conductors, Mangolt formula electro static field of single circuit three phase line and double circuit three phase line.

Learning outcomes:

After completion of MODULE III, students will be able to

- **Relate** Surface voltage gradient on conductors to capacitance calculations.(L2)
- **Explain** about maximum surface voltage gradient of bundle conductors(L5)

- **Demonstrate** importance of Mangolt formula electro static field of different circuits(L2)

Unit IV **8 L**

Corona: Corona in EHV lines, I^2R loss and corona loss, charge voltage diagram and corona loss, corona loss formulate, attenuation of traveling waves due to corona, audio noise due to corona, its generation, characteristics and limits measurement of audio noise.

Learning outcomes:

After completion of MODULE IV, students will be able to

- **outline** about Corona in EHV lines (L2)
- **Solve** attenuation of traveling waves due to corona (L6)
- **Explain** about characteristics and limits measurement of audio noise (L4)

Unit V **10 L**

UHV AC power transmission: UHV AC power transmission line parameters and major power transmission features, introduces UHV synchronous grid power angle, voltage, and frequency stability mechanisms and criterion.

Learning outcomes:

After completion of MODULE V, students will be able to

- **Apply** concepts of major power transmission features. (L3)
- **Examine** UHV synchronous grid (L4)
- **Explain** about stability mechanisms in UHV AC power transmission line. (L4)

Text Book(s):

1. Rakosh Das Begamudre, Extra High Voltage AC Transmission Engineering, 3/e, Wiley Eastem Ltd., New Delhi, 3rd edition, 1987.
2. Mazen Abdel-Salam, High-Voltage Engineering: Theory and Practice, Second Edition, Revised and Expanded, 2/e, illustrated, reprint, revised, CRC Press, 2000

Reference Books:

1. R. Arora, Wolfgang Mosch, High voltage insulation engineering: behaviour of dielectrics, their properties and applications, New Age International, 1995.
2. S.Rao, EHVAC, HVDC Transmission & Distribution Engineering, 3/e, Khannablications, 2003.

Course outcomes:

- **Apply** concepts of major power transmission features (L3).
- **Outline** about Corona in EHV lines (L2).
- **Relate** Surface voltage gradient on conductors to capacitance calculations (L2).
- **Distinguish** various power handling capacities and line losses (L4).
- **Examine** UHV synchronous grid (L4).

19EEE704: ADVANCED POWER SYSTEM OPERATION AND CONTROL

L	T	P	C
3	0	0	3

Preamble

The course deals with the development of dynamic programming for the unit commitment problem and to design an isolated power system. It is intended to help the young researchers to keep their knowledge upgraded with the power system scheduling problem and to contrast different types of power and energy interchange transactions.

Course Objectives:

The purpose of the course is to

- Study unit commitment problem.
- Learn the necessity of Load frequency control.
- Outline the Solution for production cost function by gradient search techniques.
- Expose about hydrothermal scheduling
- Distinguish types of power interchange.

UNIT 1: Unit Commitment **8 L**

Introduction, constraints in unit commitment, thermal unit constraints, unit commitment solution methods, priority-list methods, Dynamic-Programming solution, forward DP Approach, Lagrange relaxation solution. State Estimation-Power System State Estimation, Weighted Least Square Estimation, State Estimation of an AC Network.

Learning outcomes:

After completion of Unit I, students will be able to

- **Define** the unit commitment problem (L1)
- **Contrast** the priority-list methods (L2)
- **Outline** the Dynamic-Programming solution (L2)
- **Analyze** the Power System State Estimation (L4)
- **Interpret** the State Estimation of an AC Network. (L5)

UNIT 2: Load Frequency Control **8 L**

Necessity of keeping frequency constant, definition of control area, single area control, block diagram representation of an isolated power system, steady state analysis, dynamic response, uncontrolled case, load frequency control of 2-area system, uncontrolled case and controlled case, tie-time bias control

Learning outcomes:

After completion of Unit II, students will be able to

- **Illustrate** the Load frequency control (L2)
- **Define** the Control area (L1)
- **Develop** the block diagram of an isolated power system (L3)
- **Analyze** load frequency control of 2-area system (L4)
- **Appraise** the uncontrolled case and controlled case. (L5)

UNIT 3: Generation with Limited Energy Supply **8 L**

Introduction, take-or-pay fuel supply contract, composite generation production cost function, solution by gradient search techniques, hard limits and slack variables, fuel scheduling by linear programming.

Learning outcomes:
After completion of Unit III, students will be able to

- **Explain** the take-or-pay fuel supply contract (L2)
- **Demonstrate** production cost function (L2)
- **Evaluate** the solution by gradient search techniques (L5)
- **Estimate** fuel scheduling by linear programming. (L5)

UNIT 4: Hydrothermal Coordination 8 L

Introduction, long range hydro scheduling, short-range hydro-scheduling, hydroelectric plant models, scheduling problems, types of scheduling problems, scheduling energy, the short term hydro-thermal scheduling problem, short term hydro scheduling, gradient approach, pumped storage hydro plants, dynamic programming solution to the hydrothermal scheduling problem.

Learning outcomes:
After completion of Unit IV, students will be able to

- **Explain** long range hydro scheduling and short-range hydro-scheduling (L2)
- **Outline** the hydroelectric plant models (L2)
- **Distinguish** types of scheduling problems (L4)
- **Determine** the dynamic programming solution (L5)

UNIT 5: Interchange of Power and Energy 10 L

Introduction, economy interchange between interconnected utilities, inter-utility economy energy evaluation, interchange evaluation with unit commitment, multiple-utility interchange transactions, types of interchange, capacity interchange, diversity interchange, emergency power interchange, inadvertent power exchange, power pools, transmission effects and issues, problems..

Learning outcomes:
After completion of Unit V, students will be able to

- **List** economy interchange between interconnected utilities (L1)
- **Demonstrate** interchange evaluation with unit commitment (L2)
- **Categorize** multiple-utility interchange transactions (L4)
- **Compare** the types of interchange (L4)
- **Estimate** the transmission effects, issues and problems (L6)

Text Book(s)

1. Allen J. Wood, Bruce F. Wollenberg, Extra High Voltage AC Transmission Engineering, 2/e, John Wiley & Sons Inc. 2006.
2. O.I.Elgerd, Electrical Energy Systems Theory, 2/e, Tata Mc Graw-Hill Publishing Company Ltd.

Reference Book(s)

1. I.J.Nagrath & D.P.Kothari, Modern Power System Analysis, New Age International, 1995.

Course Outcomes:
Upon completion of the course, the students would be able to

- **Summarize** the Dynamic-Programming solution (L2).
- **Construct** an isolated power system model (L6).
- **Build** fuel scheduling by linear programming (L6).
- **Examine** the dynamic programming solution to the hydrothermal scheduling problem (L4).
- **Appraise** the power and energy interchange transactions (L5).

19EEE757: RESTRUCTURED POWER SYSTEMS

(Elective)

L	T	P	C
3	0	0	3

Preamble

In this course it is aimed to introduce to the students the basic principles of regulated and deregulated power markets. The basic concepts of Operational and planning activities of a GENCO, Components of restructured system, Open Access Distribution and the basic concepts of Power Market Development are analyzed.

Course Objectives:

The purpose of the course is to

- Study of various Market Models - regulated and deregulated power markets.
- Expose various basic concepts of Operational and planning activities of a GENCO.
- Familiarize various Components of restructured system.
- Expose about Open Access Distribution.
- Interpret the Power Market Development.

Unit I **10 L**

Introduction – Market Models – Entities – Key issues in regulated and deregulated power markets; Electricity markets - California Market – New England ISO – Midwest ISO - Nordic Pool– Power market in China.

Learning outcomes:

After completion of Unit I, students will be able to

Contrast the different Market Models – regulated and deregulated power markets (L2)
Contrast the different Electricity markets (L2)
Analyze New England ISO – Midwest ISO - Nordic Pool (L4)
Analyze Power market in China (L4)

Unit II **8 L**

Operational and planning activities of a GENCO - Electricity Pricing and Forecasting -Price Based Unit Commitment Design - Security Constrained Unit Commitment design. - Ancillary Services for Restructuring- Automatic Generation Control (AGC).

Learning outcomes:

After completion of Unit II, students will be able to

- **Demonstrate** the Operational and planning activities of a GENCO (L2)
- **Develop** the equations for Electricity Pricing and Forecasting (L3)
- **Survey** Security Constrained Unit Commitment design (L4)

- **Appraise** the Automatic Generation Control (L5)

Unit III **8 L**

Introduction- Components of restructured system-Transmission pricing in Open-access system-Open transmission system operation; Congestion management in Open-access transmission systems- FACTS in congestion management - Open-access Coordination Strategies; Power Wheeling-Transmission Cost Allocation Methods

Learning outcomes:

After completion of Unit III, students will be able to

- **List** the various Components of restructured system (L1)
- **Develop** Transmission pricing in Open-access system (L3)
- **Analyze** Congestion management in Open-access transmission systems (L 4)
- **Evaluate** Open-access Coordination Strategies (L5)
- **Design** Cost Allocation Methods. (L6)

Unit IV **8 L**

Open Access Distribution - Changes in Distribution Operations- The Development of Competition – Maintaining Distribution Planning.

Learning outcomes: After completion of Unit IV, students will be able to

- **Illustrate** Open Access Distribution (L2)
- **Analyze** Changes in Distribution Operations (L4)
- **Interpret** The Development of Competition (L5)
- **Formulate** Maintaining Distribution Planning. (L6)

Unit V **10 L**

Power Market Development – Electricity Act, 2003 - Key issues and solution; Developing power exchanges suited to the Indian market - Challenges and synergies in the use of IT in power- Competition- Indian power market- Indian energy exchange- Indian power exchange- Infrastructure model for power exchanges- Congestion Management-Day Ahead Market- Online power trading.

Learning outcomes: After completion of Unit V, students will be able to

- **List** out various types of - Key issues and solution (L1)
- **Demonstrate** power exchanges suited to the Indian market (L2)
- **Distinguish** Challenges and synergies in the use of IT in power (L4)
- **Elaborate** Congestion Management. (L6)

Text Book(s)

1. Loi Lei Lai, “Power System Restructuring and Deregulation”, John Wiley & son LTD, New York, 2001.

2. Mohammad Shahidehpour, Hatim Yamin, "Market operations in Electric power systems", John Wiley & son LTD, Publication, 2002.

References

1. Lorrin Philipson, H. Lee Willis, "Understanding Electric Utilities and Deregulation" Taylor & Francis, New York 2006.

2. Mohammad hahidehpour, Muwaffaq Alomoush, "Restructured Electrical Power Systems", Marcel Dekker, INC., New York, 2001.

Course Outcomes: Upon completion of the course, the students would be able to

- **Relate** various Market Models - regulated and deregulated power markets (L2).
- **Identify** various basic concepts of Operational and planning activities of a GENCO (L3).
- **Estimate** various Components of restructured system (L6).
- **Assess** about Open Access Distribution (L5).
- **Appraise** the Power Market Development. (L5).

19 EEE761: FACTS AND CUSTOM POWER DEVICES
(Elective)

L	T	P	C
3	0	0	3

Preamble

The aim of this course is to make the students familiar with and increase their knowledge for the use of power electronics both at transmission and distribution level. At the end of the course the student should have a proper understanding of the different problems that can be encountered at the different voltage levels in the power systems and how to approach and solve them.

Course Objective:

The overall objectives are as follows:

- **Enable** students to understand the problems faced by modern power utilities and how power electronic solutions can overcome these problems.
- **To introduce** the various topologies of the power electronics circuits
- **Provide** basic understanding of the emerging power electronics technologies for power utility applications
- **Familiarize** students to understand the harmonics issues in power utility and means of controlling it using power electronics
- **Expose** students to design power electronics circuit that can control active and reactive power flow

Unit I **8 L**

Power flow in Power Systems: Steady-state and dynamic problems in AC systems – Voltage regulation and reactive power flow control in Power Systems – control of dynamic power unbalances in Power System - Power flow control -Constraints of maximum transmission line loading - Benefits of FACTS Transmission line compensation.

Learning outcomes:

After completion of UnitI, students will be able to

- **Define** problems in AC systems (L1)
- **Classify** the active power and reactive power flow (L2)
- **Analyze** benefits of FACTS (L3)

Unit II **8 L**

Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control - Comparison between SVC and STATCOM.

Learning outcomes:

After completion of Unit II, students will be able to

- **Define** the SVS and STATCOM(L1)
- **Summarize** the operation shunt controllers(L2)
- **Comparing** the shunt controllers(L4)

Unit III **8 L**

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators - TCVR and TCPAR- Operation and Control –Applications, GCSC,TSSC, TCSC and Static synchronous series compensators and their control.

Learning outcomes:

After completion of Unit III, students will be able to

- **Define** the TSSC and SSSC(L1)
- **Summarize** the operation series controllers(L1)
- **Comparing** the series controllers(L4)
- **Formulate** and analyses complex problems(L6)

UNITIV **8 L**

Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- basic Principle of P and Q control- independent real and reactive power flow control- Applications - Introduction to interline power flow controller.

Learning outcomes:

After completion of Unit IV, students will be able to

- **Relate** the operation of series and shunt controllers(L1)
- **Summarize** the controlling operation (L2)
- **Select** the use different power electronic based solutions(L3)
- **Formulate** and analyses complex problems(L6)

Unit V **10 L**

Oscillation Stability Analysis and Control: Introduction, Linearised model of power systems installed with FACTS based Stabilizers, Heffron-Phillips model of a SMIB system installed with SVC.

Learning outcomes:

After completion of Unit V, students will be able to

- **Define** the stability analysis of controllers(L1)
- **Summarize** the controlling operation (L2)
- **Select** the use different models of shunt and series controllers(L3)

Text Book(s)

1.N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
2.X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", Springer Verlag, Berlin, 2006

References

1.K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
2.T J E Miller, Static Reactive Power Compensation, John Wiley and Sons, Newyork, 1982

Course Outcomes:

- **Classify** the active power and reactive power flow (L2).
- **Summarize** the operation shunt controllers (L2).
- **Formulate** and analyses complex problems (L6).
- **Select** the use different models of shunt and series controllers (L3).

19EEE763: ENGINEERING OPTIMIZATION
(Elective)

L	T	P	C
3	0	0	3

Preamble
The course deals with the different optimization techniques to solve many engineering problems. It also helps young scientists to obtain best and optimal solution with linear and non linear programming methods.

Course Objectives:
The purpose of the course is to
- Introduce Engineering applications of optimization, optimization problem formulation.
- Learn classical optimization problems for single and multi variable problems
- Learn different methods involved in Linear programming.
- Application of Non-linear programming methods to engineering problems
- Outline the network representation in solving project management problems using CPM/PERT

UNIT 1: Introduction to Optimization **8 L**
Optimization, classification of optimization problems, engineering applications of optimization, optimization problem formulation.

Learning outcomes:
After completion of Unit I, students will be able to
- **Apply** engineering applications of optimization (L3)
- **Explain** problem formulation of an optimization problem (L2)
- **Classify** the optimization problems (L4)

UNIT 2: Classical Optimization Techniques **8 L**
Necessary and sufficient conditions of the general problem. Single variable optimization. Multivariable optimization with no constraints, multivariable optimization with equality constraints. Solution by direct substitution method. Method of constrained variation. Method of Lagrangian multipliers. Multivariable optimization with inequality constraints. Kuhn – Tucker conditions.
Learning outcomes:
After completion of Unit II, students will be able to
- **Apply** classical optimization techniques for single variable and Multi variable optimization with and without constraints. (L3)
- **Develop** multivariable optimization with equality constraints (L3)
- **Evaluate** the Method of Lagrangian multipliers (L4)
- **Formulate** the Multivariable optimization with inequality constraints. (L6)

UNIT 3: Linear Programming: **8 L**
Basic terminology and definitions, exceptional cases. Simplex method, Big M method. Two phase method, duality. Revised Simplex method.

Learning outcomes:
After completion of Unit III, students will be able to
- **Define** the Linear programming (L1)
- **Compare** Simplex method and Big M method (L2)
- **Evaluate** the solution by Two phase method (L5)
- **Determine** the solution with Revised Simplex method (L5)

UNIT 4: Non linear programming **8 L**

Unconstrained optimization. Powell's method. Steepest descent method, Newton's method. Constrained optimization: Genetic Algorithm:- Introduction, Terminology- Coding, Fitness Function, GA operators, Reproduction, Crossover, Mutation.

Learning outcomes:

After completion of Unit IV, students will be able to

- **Classify** unconstrained optimization methods (L2)
- **Apply** the Powell's method, Steepest descent method and Newton's method to engineering problems (L3)
- **Explain** about the Genetic Algorithm (L4)
- **Determine** the best solution from GA (L5)

UNIT 5: CPM and PERT **10 L**

Basic Terminology, network representation of project critical path, the PERT method, optimum scheduling by CPM, LP formulation of CPM, PERT problems.

Learning outcomes:

After completion of Unit V, students will be able to

- **Define** CPM and PERT(L1)
- **Construct** network of project critical path (L3)
- **Examine** LP formulation of CPM (L4)
- **Estimate** the PERT problems (L6)

Text Book(s)

1. Singiresu S. Rao, "Engineering Optimization: Theory and Practice", 3/e, John Wiley and Sons, 2009.
2. Iyer, "Operation Research", 2/e, Tata McGraw-Hill Education, 2008.
3. S.D.Sharma, "Operation Research:Theory, Methods and Applications", Edition 15, kedar Nath Ram Nath, 2010

Reference Book(s)

1. Mitsuo Gen, Runwei Cheng, "Genetic Algorithms and Engineering Optimization", John Wiley and Sons, 2000
2. H.A. Taha, "Operations Research – An Introduction", 7/e, PHI, 2005.
3. B.S.Grewal, "Higher Engineering Mathematics" Edition 43, Khanna Publications.

Course Outcomes:

Upon completion of the course, the students would be able to

- **Classify** the optimization problems (L4).
- **Make use of** optimization techniques to solve engineering problems (L3).
- **Develop** the necessary solution from Linear and Nonlinear programming (L6).
- **Build** project crtical paths using CPM and PERT methods (L6).

19EEE742: ARTIFICIAL INTELLIGENCE TECHNIQUES

(Elective)

L	T	P	C
3	0	0	3

Preamble

This course deals the Biological foundations to intelligent Systems, Fuzzy Logic and Fuzzy Neural Networks. This course also deals application of System Identification using Fuzzy, Neural Network and Genetic algorithm.

Course Objectives:

The purpose of the course is to

- Understanding fuzzy logic, ANN
- Understanding GA & EP
- Explains the concepts of biological foundations of artificial neural networks
- Develop and Identifications of fuzzy and neural network

Unit I **10 L**

Biological foundations to intelligent Systems: Artificial Neural Networks. Single layer and Multilayer Feed Forward NN. LMS and Back Propagation Algorithm. Feedback networks and Radial Basis Function Networks

Learning outcomes:

After completion of MODULE I, students will be able to

- **Explain** about Artificial Neural Networks.(L2)
- **Develop** LMS and Back Propagation Algorithm .(L3)
- **Distinguish** Feedback and Feed forward networks.(L4)

Unit II **8 L**

Fuzzy Logic: Knowledge Representation and Inference Mechanism. Defuzzification Methods

Learning outcomes:

After completion of MODULE II, students will be able to

- **Explain** concepts of Fuzzy Logic (L2)
- **Analyze** different Knowledge Representation and Inference Mechanism (L4)
- **Combine** different Defuzzification Methods.(L6)

Unit III **8 L**

Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA

Learning outcomes:

After completion of MODULE III, students will be able to

- **Relate** key technologies in Fuzzy Neural Networks (L2)
- **Explain** about Genetic Algorithm (L5)
- **Demonstrate** importance of Genetic Algorithm (L2)

Unit IV **8 L**

Genetic algorithm: Reproduction, Cross over, Mutation, Introduction to evolutionary program

Learning outcomes:
After completion of MODULE IV, students will be able to

- **Outline** about Genetic algorithm (L2)
- **Solve** different evolutionary program (L6)
- **Explain** about different evolutionary program (L4)

Unit V **8 L**

Hybrid systems: Hybrid intelligence techniques, application in power systems.

Learning outcomes:
After completion of MODULE V, students will be able to

- **Apply** concepts of Hybrid systems. (L3)
- **Examine** different Hybrid intelligence techniques. (L4)
- **Explain** about Hybrid intelligence techniques applications to power systems (L4)

Text Book(s)

1. D.W.Patterson, Introduction to Artificial Intelligence and Expert systems, 2/e, PHI, 2009.

References

1. Yong-Hua Song, Allan Johns, Raj Aggarwal, Computational Intelligence Applications to Power Systems, Science Press, 1/e, Kluwer Academic Publishers, 1997.

Course Outcomes:

- **Develop** LMS and Back Propagation Algorithm (L3).
- **Solve** different evolutionary program (L6).
- **Apply** concepts of Hybrid systems (L3).

19EEE744: ELECTRIC POWER QUALITY
(Elective)

L	T	P	C
3	0	0	3

Preamble

In this course it is aimed to introduce to the students the knowledge on need for power supply quality, factors affecting the power quality, their sources, effects and solutions. The basic concepts of various power quality problems occurring in electrical distribution system and brief idea about their solutions are explained.

Course Objectives:

The purpose of the course is to

- Define various terms and basic concepts of power quality issues
- Explain the power quality phenomena, sources and its effects
- Classify long and short interruptions
- Analyze the voltage sag characteristics and harmonics
- Interpret the working of DSTATCOM, DVR and UPQC

Unit I **8 L**

Introduction: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Sources of PQ problems, power quality monitoring.

Learning outcomes:

After completion of Unit I, students will be able to

- **Define** the basic concepts and various terms in electric power quality. (L1)
- **Illustrate** various surges and harmonics in power systems (L2)
- **Analyze** the sources and causes of power quality problems (L4)
- **Categorize** various methods to improve power quality in power system. (L6)
- **Estimate** various power quality monitoring conditions. (L6)

Unit II **8 L**

Long & Short Interruptions: Long Interruptions: Terminology causes and origin of Interruptions, Limits for the Interruption frequency and duration, costs of Interruption. Short interruptions: Terminology, origin of short interruptions- basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption and monitoring, difference between medium and low voltage systems. Multiple events, single phase tripping - voltage and current during fault and post fault period.

Learning outcomes:

After completion of Unit II, students will be able to

- **Define** the basic concepts of long and short interruptons (L1)
- **Explain** the sources and causes of long and short interruptons (L2)
- **Distinguish** the origin of short interruptions(L4)
- **Discuss** single phase tripping (L6)

Unit III **8 L**

Voltage sag – characterization: Voltage sag - definition, causes of voltage sag, voltage sag magnitude-monitoring, theoretical calculations, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration, Types of three phase unbalanced sags, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

Learning outcomes:

After completion of UNIT III, students will be able to

- **Define** the basic concepts of Voltage sag (L1)
- **Explain** the sources and causes of Voltage sag (L2)
- **Analyze** the theoretical calculations of voltage sag in various systems (L4)
- **Compare** various types of three phase voltage sags (L5)

Unit IV **8 L**

Harmonics: Harmonic distortion, Voltage versus Current distortion, Harmonic indexes, Harmonic sources from commercial loads, Harmonic sources from industrial loads; Locating Harmonic sources, System response characteristics. Effects of Harmonic Distortion.

Learning outcomes:

After completion of UNIT IV, students will be able to

- **Define** the basic concepts of Harmonics (L1)
- **Demonstrate** various terms used in harmonics (L2)
- **Identify** the harmonic sources from various loads (L3)
- **Analyze** the effects of harmonic distortion(L4)

Unit V **8 L**

Custom Power Devices:

An Introduction: Overview of mitigation methods - from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. Utility-Customer Interface, Introduction to CP devices-Network Reconfiguring Devices, Load Compensation and Voltage Regulation using DSTATCOM, Protecting Sensitive loads using DVR, Unified Power Quality Conditioner (UPQC).

Learning outcomes:

After completion of UNIT V, students will be able to

- **List** out various mitigation methods (L1)
- **Explain** the various events and mitigation methods (L2)
- **Categorize** the custom power devices (L4)
- **Explain the** working of DSTATCOM , DVR and UPQC (L5)
- **Develop** control strategies for DSTATCOM, DVR and UPQC. (L6)

Text Book(s)

1. Math H J Bollen, "Understanding Power Quality Problems,,1/e, IEEE Press, Standard Publishers Distributors, 2001.
2. Arindham Ghosh, Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices, 1/e, Kluwer Academic Publishers, 2002

References

1. Roger C.Dugan, Mark F.McGranaghan, Surya Santoso, H. Wayne Beaty, Electrical Power System Quality, 2/e, McGraw-Hill, 2004.

Course Outcomes:
Upon completion of the course, the students would be able to

- **Explain** the importance of power quality (L2).
- **Explain** about power quality problems, categories, causes and its effects (L2).
- **Estimate** various parameters in power quality problems (L5).
- **Appraise** the working of various custom power devices (L5).
- **Develop** control strategies for DSTATCOM, DVR and UPQC (L6).

19EEE746: POWER CONVERSION TECHNIQUES
(Elective)

L	T	P	C
3	0	0	3

Preamble

In this course it is aimed to introduce the student's fundamental concepts on conversion, control and monitoring of electric energy using power semiconductor devices. Methods for analyzing power electronic converters suitable for AC/DC, DC/DC and DC/AC electrical energy conversions, loss calculations and thermal management are explained.

Course Objectives:

The purpose of the course is to

- Expose the basic concepts of various types of power converters
- Explain the theory of electrical energy conversion using power electronic systems that perform AC/DC, DC/DC , DC/AC and AC/AC conversion
- Interpret the working of various types of power converters
- Analyze advanced converters and switching techniques implemented in recent technology
- Discuss on loss calculations and thermal management

Unit I **8 L**

DC-DC converters-Buck converter, boost converter, buck-boost converter, averaged circuit modeling, input-output equations, ripple calculations, filter design.

Learning outcomes: After completion of Unit I, students will be able to

- **List** the various types of DC to DC converters (L1)
- **Classify** the DC to DC converters(L2)
- **Develop** the converters for various applications(L3)
- **Analyze** the performance of converters (L4)

Unit II **8 L**

DC-AC inverters -Single phase VSI, Three phase VSI, Single phase CSI, Three phase CSI, voltage control and harmonic reduction in inverters-standard PWM techniques.

Learning outcomes: After completion of Unit II, students will be able to

- **List** the various types of inverters (L1)
- **Compare** various types of inverters(L2)
- **Develop** the inverters for various applications(L3)
- **Explain** various pulse width modulation techniques (L5)

Unit III **10 L**

AC-DC converters- Uncontrolled (Diode rectifier), single and three phase fully controlled (SCR-line commutated) and semi controlled converters, continuous current conduction, discontinuous current conduction, Reactive compensation, Harmonic compensation techniques.

Learning outcomes: After completion of Unit III, students will be able to

- **Classify** the various types of Ac to DC converters (L2)
- **Explain** various current conduction methods(L2)
- **Develop** the converters for various applications(L3)
- **Analyze** various compensation techniques (L4)

Unit IV **8 L**

AC-AC converters-single phase and three phase circuits employing Phase angle control, on-off control. AC choppers.

Learning outcomes: After completion of Unit IV, students will be able to

- **List** the various types of converters (L1)
- **Explain** various controlling techniques(L2)
- **Make use of** the converters for various applications(L3)
- **Discuss** AC Choppers(L6)

Unit V **10 L**

Loss calculations and thermal management: Device models for loss calculations, ratings, safe operating areas, data sheets, forward conduction loss, switching losses, heat sink design, snubber design drive and protection circuits, commutation circuits, soft switching.

Learning outcomes: After completion of Unit V, students will be able to

- **Demonstrate** the device models for loss calculations (L2)
- **Explain** various design parameters of power converters(L2)
- **Analyze** various circuits interfaced with converters (L4)
- **Discuss** fundamentals of soft switching (L6)

Text Book

1. B. Woo, "High Power Converters and AC Drives", John Wiley & Sons, 2006
2. Ned Mohan et.al , "Power Electronics" ,John Wiley and Sons,2006

Reference:

1. Rashid, "Power Electronics, Circuits Devices and Applications", Pearson Education, 3rd edition, 2004.
2. G.K. Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993
3. Cyril W Lander, Power Electronics, McGraw Hill, 3rd edition, 1993

Course Outcomes: Upon completion of the course, the students would be able to

- **Explain** the importance of power converters (L2).
- **Classify** various types of DC/DC, DC/AC, AC/DC and AC/AC converters (L4).
- **Analyze** operating principles and modulation strategies of power converters (L4).
- **Make use of** advanced modeling and control of power electronic converters (L3).
- **Discuss** design parameters and to recognize the impact of operating parameters on the planning and use of power electronic converters (L6).

19EEE748: PLC, SCADA and Automation

(Elective)

L	T	P	C
3	0	0	3

Preamble

In Present global scenario of manufacturing, industries are moving towards complete automation. Small and medium scale industries require PLC and SCADA technology for the data acquisition and control. Therefore, it is necessary for electronics engineers to have knowledge of both PLC and SCADA technology. This course attempts to provide basic configurationally knowledge of these technology to develop operational competency. Hence this course is foundation for the engineers who want to specialize in PLC and SCADA.

Course Objectives:

- Explain the basics of MIMO systems and calculation of system norms
- Analyze the concept of robustness and robust stability using H-infinity theory.
- Design the hardware and programming of programmable logic controllers
- Outline the real time systems and inter task communication.
- Discuss the fundamentals of PLC and its architecture.
- Develop the PLC programming fundamentals, process logic and human machine interface.
- Selection of SCADA architecture and communication protocols.
- Illustrate DCS architecture and configuration.
- Survey of case studies of PLC, SCADA and DCS.
- Summarize the inter task communication, synchronization and real time memory

UNIT I: **8 L**

Multivariable control: Basic expressions for MIMO systems. Singular values, stability norms. Calculation of system norms. Robustness, robust stability, H^2/ H theory. Solution for design using H2/ H, case studies. Interaction and decoupling, Relative gain analysis, Effects of interaction, Response to disturbances. Decoupling. Introduction to batch process control.

Learning Outcomes:

After completion of Module I, the students will be able to

- **Analyze** external and internal descriptions of multivariable systems. (L4)
- **Classify** control and analysis techniques of multivariable systems. (L2)
- **Identify** the general control problem formulation with and without uncertainty and the concepts of robust stability and robust performance. (L3)
- **Apply** various methods in controller design for multivariable systems. (L3)
- **Demonstrate** the basic aspects of the methods for model reduction and for those problems which appear in controllers' implementations. (L2)

UNIT II: **8 L**

Programmable logic controllers: Organization, hardware detail, I/O, power supply, CPU. Standards, programming aspects. Ladder programming. Sequential function charts. Man, machine interface. Detailed study of one model. Case studies.

Learning Outcomes:

After completion of Module II, the students will be able to

- **Classify** various parts of the given PLC and front panel status indicators. (L2)
- **Develop** and test ladder program for pulse counting using limit switch /Proximity sensor. (L3)
- **Examine** ladder program for math instruction. (L4)
- **Evaluate** ladder program for data handling instructions. (L5)

UNIT III: **8L**

SCADA: SCADA architecture, different communication protocols, common system components, supervision and control, HMI, RTU and supervisory stations, trends in SCADA, security issues.

Learning Outcomes:

After completion of Module III, the students will be able to

- **Tell** the architecture of SCADA. (L1)
- **Analyze** functions of SCADA simulation editors to develop simple project. (L4)
- **Develop** a SCADA mimic diagram and tag database for Traffic light control system. (L3)
- **Take part in** case study of security issues. (L4)

UNIT IV: **8 L**

Distributed control systems: Architecture, local control (LCU) architecture, LCU languages, LCU process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept, case studies in DCS.

Learning Outcomes:

After completion of Module IV, the students will be able to

- **What** is the architecture of DCS. (L1)
- **Tell** the architecture of LCU. (L1)
- **Demonstrate** the process interfacing issues. (L2)
- **Distinguish** configurations of DCS. (L4)
- **Analyze** the case study of DCS**.** (L4)

UNIT V: **10 L**

Real time systems: Real time specifications and design techniques, real time kernels, inter task communication and synchronization. Real time memory management. Supervisory control, direct digital control. Distributed control, PC based automation.

Learning Outcomes:

After completion of Module V, the students will be able to

- **Tell** specifications of real time system. (L1)
- **Demonstrate** the task of communication and synchronization. (L2)
- **Explain** the applications of digital control. (L5)
- **Discuss** PC based industrial automation. (L6)

Text Book(s)

1. F.G Shinskey., Process control systems: Application, Design and Tuning, 4/e, McGrawHill, 1996.
2. P.R Be.langer, Control Engineering: A Modern Approach, Saunders College Publishing, 1995.

References

1.R.C .Dorf and Bishop R. T. , Modern Control Systems, 11/e, Addison Wesley Longman., 2008.
2.P.A Laplante., Real Time Systems: An Engineer.s Handbook, PHI, 2007.
3. CH. Houpis and Gary B. Lamont, Digital Control systems, McGraw Hill, 1985.

Course Outcomes:

At the end of the course the students will be able to

- **Explain** about different components of PLC (L2).
- **Apply** appropriate PLC module for given application (L3).
- **Identify** SCADA components as per requirement (L3).
- **Demonstrate** a simple DCS application (L2).
- **Apply** PC based on automation (L3).
- **Understand** the specifications and design techniques in real time system analysis. (L4)

19EEE752: POWER SYSTEM TRANSIENTS

(Elective)

L	T	P	C
3	0	0	3

Preamble

In this course it is aimed to introduce to the students the Fundamentals of circuit analysis of electrical transients systems. The basic Principle of digital computation, Interaction between lightning and power system, Switching HVDC line travelling waves on transmission line and Insulation co-ordination are analyzed.

Course Objectives:

The purpose of the course is to

- Study the generation of switching transients and their control using circuit – theoretical concept.
- Study the Principle of digital computation
- Study the mechanism of lighting strokes and the production of lighting surges.
- Study the propagation, reflection and refraction of travelling waves.
- Study the impact of voltage transients caused by faults, Lightning arresters. Substation earthing.

Unit I **10 L**

Fundamental circuit analysis of electrical transients: Laplace Transform method of solving simple Switching transients. Damping circuits -Abnormal switching transients. Three-phase circuits and transients. Computation of power system transients.

Learning Outcomes

After completion of Unit I students will be able to

- **Apply** Laplace Transform method of solving simple Switching transients.(L3)
- **Demonstrate** Damping circuits. (L2)
- **Classify** the different types of switching transients. (L2)
- **Illustrate** the power system transients. (L2)

Unit II **8 L**

Principle of digital computation – Matrix method of solution. Modal analysis- Z transform. Computation using EMTP. Lightning, switching and temporary over voltages. Lightning: Physical phenomena of lightning.

Learning Outcomes

After completion of Unit II students will be able to

- **Apply** Matrix method of digital computation. (L3)
- **Apply** Z transform, Computation using EMTP. (L3)
- **Classify** Lightning, switching and temporary over voltages. (L2)
- **Demonstrate** Physical phenomena of lightning.(L2)

Unit III **8 L**

Interaction between lightning and power system. Influence of tower footing resistance and Earth Resistance. Switching: Short line or kilometric fault. Energizing transients - closing and re-closing of lines. Line dropping, load rejection. Over voltages induced by faults.

Learning Outcomes

After completion of Unit III students will be able to

- **Explain** Interaction between lightning and power system. (L2)
- **Compare** Influence of tower footing resistance and Earth Resistance. (L4)
- **Classify** the types of transients. (L4)
- **Explain** Line dropping, load rejection. Over voltages induced by faults. (L5)

Unit IV **8 L**

Switching HVDC line Travelling waves on transmission line: Circuits with distributed Parameters. Wave Equation. Reflection, Refraction. Behaviour of Travelling waves at the line terminations. Lattice Diagrams – Attenuation and Distortion. Multi-conductor system and Velocity wave.

Learning Outcomes

After completion of Unit IV students will be able to

- **Design** Circuits with distributed Parameters.(L6)
- **Estimate** Wave Equation, Reflection, Refraction (L5)
- **Discuss** Behaviour of travelling waves at the line terminations. (L6)
- **Design** Lattice Diagrams – Attenuation and Distortion. Multi-conductor system and Velocity wave. (L6)

Unit V **8 L**

Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS). Protective devices- Protection of system against over voltages. Lightning arresters. Substation earthing.

Learning Outcomes

After completion of Unit V students will be able to

- **Estimate** the Effect of Insulation co-ordination. (L6)
- **Demonstrate** the Protective devices (L2)
- **Compare** Air Insulated substation (AIS) and Gas Insulated Substation (GIS). (L5)
- **Discuss** Protection of system against over voltages. (L6)
- **Explain** Lightning arresters. Substation earthing. (L5)

Text Book(s):

1. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991

References

1. C.S.Indulkar, D. P. Kothari, K. Ramalingam," power system transients-A Statistical Approach" PHI, 2nd Edition.

Course Outcomes:

Upon completion of the course, the students would be able to

- Relate various circuit analyses of electrical transients (L2).
- Apply the Principle of digital computation (L3).
- Assess about Interaction between lightning and power system (L5).
- Estimate Switching HVDC line Travelling waves on transmission line (L6).
- Appraise the Insulation co-ordination. (L5)

19EEE754 : POWER SYSTEM PLANNING AND RELIABILITY

(Elective)

L	T	P	C
3	0	0	3

Preamble

Electric power networks are prime examples of systems where a high degree of reliability is expected. Reliability is one of the major factors in the planning, design, operation, and maintenance of electric power system. The reliability of electric power supply system has been defined as the probability of providing the users with continuous service of satisfactory quality. Power system reliability assessment is divided into two basic aspects: System Adequacy and System Security. Adequacy relates to the existence of sufficient facilities within the system to satisfy the consumer load demand with system operational constraints. This subject concerns with Adequacy Assessment of Electric Power System. In this subject students will be able to use the basic probability methods to evaluate the reliability of power system and Assess the different models of system components in reliability studies.

Course Objectives:

The purpose of the course is to

- Study the objectives of short and long term planning.
- Expose various basic concepts of probability theory and distribution.
- Model the series and parallel systems.
- Analyse the Markov modelling and concepts of STPM approach.
- Interpret the feasibility of micro-hydel electric systems.
- Apply various indices for distribution systems.

Unit I **10 L**

Objectives of planning: Long and short term planning -Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

Learning Outcomes:

After completion of Unit I, the students will be able to

- **Demonstrate** the objectives of long and short term planning. (L2)
- **Classify** characteristics of loads. (L2)
- **Define** load forecasting .(L1)
- **Apply** the concepts of annual and monthly peak demand forecasting. (L3)

Unit II **8 L**

Basics of Probability theory & Distribution: Basic probability theory, rules for combining probabilities of events, Bernoulli's trials, probabilities density and distribution functions, binomial distribution, expected value and standard deviation of binomial distribution

Learning Outcomes:

After completion of Unit II, the students will be able to

- **Understand** the concept of probability theory, distribution, network modelling and reliability analysis. (L2)
- **Distinguish** different types of rules for combining probabilities of events. (L4)
- **Demonstrate** probability and distribution functions. (L2)
- **Determine** expected value and standard deviation of binomial distribution. (L5)

Unit III **8 L**

Network Modelling and Reliability Analysis: Analysis of series, parallel, series, parallel networks, complex networks, decomposition method, reliability functions f(t), F(t), R(t), H(t) and their relationships, exponential distribution, expected value and standard deviation of exponential distribution, reliability analysis of series parallel networks using exponential distribution, bath tub curve, reliability measures MTTF, MTTR, MTBF

Learning Outcomes:

After completion of Unit III, the students will be able to

- **Model** Series ,parallel and complex systems. (L3)
- **List** Reliability functions. (L1)
- **Demonstrate** Reliability Measures. (L4)
- **Determine** the shape of reliability function. (L5)

Unit IV **8 L**

Markov Modelling, Markov chains, Concept of stochastic transitional probability matrix (STPM), evaluation of limiting state probabilities, Markov Process one component repairable system, time dependent probability, evaluation using Laplace Transform approach.

Learning Outcomes:

After completion of Unit IV, the students will be able to

- **Illustrate** the reliability functions with their relationships and Markov modelling. (L2)
- **Apply** knowledge in the domains of stochastic processes for reliability study. (L3)
- **Evaluate** Time dependent probability method. (L4)

Unit V **8 L**

Generation& Distribution System Reliability Analysis: analysis: Reliability model of a generation system, recursive relation for unit addition and removal. Load modeling, merging of generation load model, evaluation of transition rates for merged state model. Cumulative probability, cumulative frequency of failure evaluation, LOLP, LOLE, distribution system, basic concepts, evaluation of basic and performance reliability indices of radial networks.

Learning Outcomes:

After completion of Unit V, the students will be able to

- **Demonstrate** the reliability applications to generation and distribution systems (L2)
- **Identify** the generation system model and recursive relation for capacitive model building (L3)
- **Evaluate** the equivalent transitional rates, cumulative probability and cumulative frequency model (L4)
- **Explain** different types of reliability indices evaluation methods for radial distribution systems (L4)

Text Book(s)

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System",2/e, Plenum Press, New York, 2010.
2. Sullivan, R.L., "Power System Planning", Heber Hill, 1987, Reprint 2010.

References

1. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering"., TATA-McGraw Hill edition.

Course Outcomes:

- **Demonstrate** the objectives of long and short term planning. (L2)
- **Model** Series, parallel and complex systems. (L3)
- **Apply** knowledge in the domains of stochastic processes for reliability study. (L3)
- **Evaluate** the equivalent transitional rates, cumulative probability and cumulative frequency model. (L4)

19EEE756: INDUSTRIAL LOAD MODELING AND CONTROL
(Elective)

L	T	P	C
3	0	0	3

Preamble

This course provides knowledge in load modelling and its ease to study load demand industrially, electricity pricing, reactive power management in industries, load control techniques, load management to reduce the demand of electricity during peak and different energy saving methods. This course is base for other subjects like Power systems analysis and Power system operation and control.

Course Objectives: The purpose of this course is

- To introduce energy demand scenario.
- To expose different types of electricity pricing schemes.
- To impart the concepts of Reactive power management in industries.
- To familiarize the concepts of load modelling.
- To expose the students the ideas of power operating and control strategies.

Unit I: **10 L**

Electric Energy Scenario-Demand Side Management-Industrial Load Management. Load Curves-Load Shaping Objectives-Methodologies-Barriers. Classification of Industrial Loads- Continuous and Batch processes -Load Modelling

Learning Outcomes:

After completion of Unit I, the students will be able to

- **Demonstrate** load modelling. (L2)
- **Classify** industrial loads. (L2)
- **Define** load curve (L1)
- **Apply** the concepts of load shaping. (L3)

Unit II: **8 L**

Electricity pricing – Dynamic and spot pricing –Models. Direct load control- Interruptible load control. Bottom up approach- scheduling- Formulation of load models. Optimization and control algorithms. Case studies.

Learning Outcomes:

After completion of UnitII, the students will be able to

- **Distinguish** different types of electricity pricing methods. (L4)
- **Demonstrate** load control methods. (L2)
- **Demonstrate** load optimization and control algorithms. (L3)
- **Determine** load control algorithms for different case studies. (L5)

Unit III: **8 L**

Reactive power management in industries-controls. Power quality impacts-application of filters Energy saving in industries

Learning Outcomes:

After completion of Unit III, the students will be able to

- **Demonstrate** reactive power management in industries. (L2)
- **Tell** applications of filters. (L1)
- **Demonstrate** energy saving methods. (L4)
- **Determine** the power quality impacts. (L5)

Unit IV: **8 L**

Cooling and heating loads Load profiling- Modeling. Cool storage-Types-Control strategies. Optimal operation. Problem formulation. Case studies

Learning Outcomes:

After completion of Unit IV, the students will be able to

- **Tell** cooling and heating loads. (L1)
- **Demonstrate** optimal operation. (L2)
- **Distinguish** cool storage types. (L4)
- **Determine** problem formulation**.** (L5)

Unit V: **8 L**

Captive power units- Operating and control strategies. Power Pooling- Operation models. Energy banking. Industrial Cogeneration

Learning Outcomes:

After completion of Unit V, the students will be able to

- **Tell** power pooling. (L1)
- **Demonstrate** operating control strategies for captive power units. (L2)
- **Demonstrate** energy banking. (L2)
- **Demonstrate** industrial cogeneration. (L2)

Text Books:

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Netherlands,1989 2. C.W. Gellings and S.N. Talukdar, . Load management concepts. IEEE Press, New York, 1986,pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS,April 1981.

Reference Books:

1. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
2. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers,NewDelhi, 1995
3. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planninginIndustrial facilities", IEEE Inc, USA

Course Outcomes:

At the end of the course the students will be able to

- Explain about load control techniques in industries and its application. (L2)
- Apply load management to reduce demand of electricity during peak time. (L3)
- Apply different energy saving opportunities in industries. (L3)
- Determine reactive power management in industries. (L5)
- Demonstrate optimization and control algorithms. (L2)

19EEE722: ADVANCED POWER SYSTEM LABORATORY

L	T	P	C
0	0	4	2

Preamble *In this course it is aimed to introduce to the students the advanced techniques in advanced power system laboratory*

Course Objectives:

The purpose of the course is to

- Experiment with transmission line model.
- Demonstrate the transmission line bi directional power flow.
- Analyze the characteristics of different relays.
- Expose programming to estimate generator outage sensitivity factor and line outage sensitivity factors.
- Show the Volt-amp characteristics of PV Panel and control of substation.

Minimum of TEN experiments to be conducted from the following:

1. Determination of efficiency and regulation of Transmission line using power circle diagram.
2. Transmission line bi directional power flow.
3. Reactive power compensation of transmission line (series compensation only).
4. Load flow analysis of 2-bus system with STATCOM.
5. ATC calculation using an existing load flow program.
6. Study of variable speed WECS (DFIG/PMSG).
7. LU decomposition and sparsity.
8. Power system state estimation using Weighted Least square error method.
9. Program to calculate generator outage sensitivity factor of a standard power system.
10. Program to calculate Line outage sensitivity factor of a standard power system.
11. Volt-amp characteristics of PV Panel.
12. Grid side/rotor side control of DFIG/PMSG based Wind energy conversion system.
13. 400/220kV substation and 220kV transmission line model with SCADA
14. 11kV Distribution station model with SCADA

Learning outcomes:

After completion, students will be able to

- **Dissect** the parts of transmission line .(L1)
- **Determine** the suitable compensation for transmission line (L5)
- **Estimate** the Load flow in transmission line(L6)
- **Analyze** performance of PV Panel and WECS (L4)
- **Decide** the suitable controllers for Wind energy conversion system(L5)

19EEE724 :ARTIFICAL INTELLIGENCE LABORATORY

L	T	P	C
0	0	4	2

Preamble

In this course it is aimed to introduce to the students the different artificial intelligence methods.

Course Objectives:

The purpose of the course is to

- Study of various algorithms used in artificial intelligence.
- Expose various basic concepts of artificial intelligence.
- Familiarize programming skills in implementing the algorithms.
- Expose about issues in various methods.
- Interpret the feasibility of methods in different applications.

List of Programs:

1. Write a program for Best first Search
2. Write a Program to A *Search algorithm
3. Write a Program to Tic-Tac Toe game for (XO)
4. Write a Program for min-max algorithm
5. Write a Program for Greedy search algorithm
6. Write a Program for Vehicle Routing Problem
7. Write a Program for Nurse Scheduling Problem
8. Write a program for Knap Sack Problem
9. Write a Program for Map coloring Problem
10. Comparing the Search methods – VR, NS, Knapsack, MC

Learning outcomes:

After completion, students will be able to

- **Define** the basic algorithms in artificial intelligence(L1)
- **Contrast** the difference between each methods(L2)
- **Identify** the different ways to implement the methods (L3)
- **Analyze** different methods of artificial intelligence(L4)
- **Justify** the use of various methods. (L5)

19EAC741: ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

This course introduces the student, to the different aspects of research paper writing including planning, preparation, layout, literature review write-up etc. Specifically the perspective and style of writing in different sections of a research paper is highlighted. Students will exposed to English language skills relevant to research paper writing.

Course Objectives:

- To write clearly, concisely and carefully by keeping the structure of the paper in mind.
- To use standard phrases in English and further improve his command over it.
- To write with no redundancy, no ambiguity and increase the readability of the paper.
- To plan and organize his paper by following a logical buildup towards a proper conclusion.
- To decide what to include in various parts of the paper.
- To write a suitable title and an abstract in order to attract the attention of the reader.
- To identify the correct style and correct tense.
- To retain the scientific value of the paper by using minimum number of words.

Unit I **5L**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Learning Outcomes:

After the completion of this unit, the student will be able to

- To know the expectations of various journals and referees (L2)
- To know the typical structure of a paper (L3)
- Learn to put words in a sentence in the correct order (L4)
- To write short and clear sentences from the very beginning of the paper (L4)
- To increase the readability of the paper by making it easy to read and 100% clear (L4)
- Learn to be concise without losing any important content (L4)
- To avoid some typical grammar mistakes made in research papers (L4)

Unit II **5L**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Learning Outcomes:

After the completion of this unit, the student will be able to

- Learn to make useful contribution worth recommending for publication (L4)
- Learn good use of language to make readers notice the key findings (L4)
- Learn to anticipate or predict possible objections to the claims made in the paper(L5)
- To understand what is plagiarism, and how to paraphrase other people's work (L4)
- Learn to attract the right kind of readers with a suitable title(L3)
- Learn to sell the abstract to potential readers by attracting their curiosity (L2)

Unit III **6L**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Learning Outcomes:

After the completion of this unit, the student will be able to

- have a deep knowledge about everything that has been previously written on the topic and decide what is important to know in Introduction. (L3)
- Learn to provide the right amount of literature regarding the sequence of events leading up to the current situation in the Literature review(L4)

Unit IV **6L**

Writing Skills: skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

Learning Outcomes:

After the completion of this unit, the student will be able to

- Learn to describe the materials used in experiments and/or the methods used to carry out the research (L2)
- The key skill is in reporting the results simply and clearly(L3)
- Learn to structure the Discussion and satisfy the typical requirements of the referees (L4)
- Learn to provide a clear and high-impact take-home message in the conclusion (L5)

Unit V **6L**

Good Paper Writing: Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Learning Outcomes:

After the completion of this unit, the student will be able to

- Learn various lists of frequently used phrases that have a general acceptance in all disciplines and use in specific sections of the paper (L3)
- Learn various kinds of things one should look for when doing the final check (L3)

Text Book (s**):**

1. Goldbort R, Writing for Science, Yale University Press, 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM, Highman, 1998.

References:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:

By the end of the course the students will be able to:

- Frame the structure of the paper precisely. (L2).
- Improve his command over English by using standard phrases. (L3).
- Avoid repetition and mistakes in the paper and increase its readability. (L3).
- Organize the paper logically towards a proper conclusion. (L4).
- Decide on the content to be included in various parts of the paper. (L5).
- Identify whether to use personal or impersonal style in the paper. (L5).
- Express the content in a clear and concise way. (L6).
- Attract the attention of the reader by providing a suitable title and an appropriate abstract. (L6).

19EAC742: DISASTER MANAGEMENT

L	T	P	C
2	0	0	0

This course is intended to provide fundamental understanding of different aspects of Disaster Management. It will expose the students to the concept and functions of Disaster Management and to build competencies of Disaster Management professionals and development practitioners for effective supporting environment as put by the government in legislative manner. It would also provide basic knowledge, skills pertaining to Planning, Organizing and Decision-making process for Disaster Risk Reduction.

Course Objectives

- to provide students an exposure to disasters, their significance, types & Comprehensive understanding on the concurrence of Disasters and its management.
- to ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures.
- equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision-making and Problem solving methods for Disaster Management.
- to develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Unit I **5L**

Introduction Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning, list the factors and mention the significance of disaster (L1)
- distinguish between hazard and disaster (L3)
- compare manmade and natural disaster (L3)
- list the types of disaster and describe their magnitude (L2)

Unit II **5L**

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the different repercussions of disasters and hazards(L1)
- describe the characteristics of natural disasters and the magnitude of their losses(L2)
- describe the characteristics of man-made disasters and the magnitude of their losses(L2)
- elaborate the outbreaks of diseases and epidemics after disasters (L3)

Unit III **6L**

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the seismic zones and their characteristics(L2)
- identify the areas prone to floods and droughts(L1)
- distinguish between landslides and avalanches(L3)
- identify areas prone to cyclonic and costal hazards(L4)
- enumerate the post disaster diseases and epidemics(L2)

Unit IV **6L**

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, media reports: governmental and Community Preparedness.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the monitoring of phenomena triggering a disaster/hazard(L2)
- evaluate the risk with the use of remote sensing and meteorological data(L5)
- list the governmental and community measures for disaster preparedness(L2)

Unit V **6L**

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Learning Outcomes

After the completion of this unit, the student will be able to

- define and list the elements of disaster risk(L1)
- enumerate the measures for risk reduction(L2)
- apply the techniques of risk assessment (L4)
- identify the means of people's participation in risk assessment(L2)

Text Book(s):

1. R. Nishith, Singh A.K., Disaster Management in India: Perspectives, issues and strategies, New Royal Book Company., 2008.
2. Sahni, Pardeep, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi., 2012
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep and Deep Publication, 2007.

Course Outcomes

At the end of the course, student will be able to

- Identify management activities in pre, during and post phases of Disasters. (L1)
- Plan disaster management activities and specify measure for risk reduction(L4)
- apply risk assessment techniques in real life disaster scenarios(L4)

19EAC744: VALUE EDUCATION

L	T	P	C
2	0	0	0

This course is intended to expose the student to the need for human values and methods to cultivate them for leading an ethical life with good moral conduct. Students taking this course will be able to experience a change in personal and professional behavior with these ethical principles guiding him throughout life

Course Objectives

- to expose the student to need for values, ethics, self-development and standards
- to make the student understand the meaning of different values including duty, devotion, self-reliance etc.
- to imbibe the different behavioral competencies in students for leading an ethical and happy life
- to expose the student to different characteristic attributes and competencies for leading a successful, ethical and happy profession life.

Unit I **7L**

Values and self-development –social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

Learning Outcomes

After the completion of this unit, the student will be able to

- define the social values and individual attitudes for self development(L1)
- describe the Indian vision of humanism(L2)
- distinguish between moral and non-moral acts (L3)
- list the standards and value principles for moral conduct (L2)

Unit II **7L**

Importance of cultivation of values. Sense of duty. Devotion, self-reliance. Confidence, concentration. Truthfulness, cleanliness. Honesty, humanity. Power of faith, national unity. Patriotism, love for nature, discipline.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the importance of cultivating values(L2)
- list the different traits of self-developed individual(L1)
- explain the need for loving nature/country/humanity(L2)

Unit III **7L**

Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the benefits of positivie thinking, integrity and discipline(L2)
- list the different methods for avoiding fault finding, anger(L1)
- explain the methods to overcome suffering, religious intolerance, self-destructive habits(L2)

Unit IV **7L**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the science of reincarnation(L2)
- explain the relation between self-management and good health(L1)
- elaborate the role of different religions in reaching the common goal(L3)
- list the different techniques for mind-control to improve personality and studies(L1)

Text Book(s):

1. Chakroborty S.K., "Values and ethics for organizations: Theory and Practice", Oxford University Press, 1998.

Course Outcomes

After successful completion of the course, the student will be able to

- describe the need for human values and methods for self development (L2)
- elaborate the different traits and benefits of a self-developed individual (L1)
- list the different attributes of self-developed individual (L1)
- elaborate the role and scope of books/faith/health/religions in character building and competence development(L3)

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19EAC745: CONSTITUTION OF INDIA

L	T	P	C
2	0	0	0

This course is intended to expose the student to the philosophy of Indian constitution. Students will be able to understand their fundamental rights/duties and governance structure. Students also appreciate the role of election commission in establishing a democratic society.

Course Objectives

- to familiarize the student about the need for a constitution
- to make the student understand the role of constitution in a democratic society
- to acquaint the student with key constitutional features and fundamental rights of a citizen
- to impart the organs of governance and local administration hierarchy and their responsibilities
- to familiarize the student with the role, responsibilities and administration hierarchy of election commission

Unit I **5L**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working).
Philosophy of the Indian Constitution: Preamble, Salient Features

Learning Outcomes

After the completion of this unit, the student will be able to

- list the outline of drafting committee and their roles in the making of Indian constitution (L1)
- describe the need and role of a constitution in a democratic society(L2)
- elaborate the salient features of Indian constitution(L3)

Unit II **5L**

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the fundamental rights of a citizen(L1)
- explain the intricacies in the different rights(L2)
- elaborate the fundamental duties of a citizen(L3)
- describe the principles of state policy(L2)

Unit III **6L**

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Learning Outcomes

After the completion of this unit, the student will be able to

- present the hierarchy of governance (L2)
- list the role/responsibilities/powers of different organs of governance(L1)
- elaborate the guidelines for appointment/transfer of judges(L2)

Unit IV **6L**

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the administrative organizational hierarchy of municipalities and panchayats(L2)
- appreciate the role/responsibilities/powers of mayor, CEO, elected officials(L3)
- appreciate the importance of grass root democracy(L3)

Unit V **6L**

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the administrative hierarchy of election commission(L2)
- elaborate the roles/responsibilities/powers of election commissioners at different levels of hierarchy(L3)
- outline the welfare activities of SC/ST/OBC/Women by different bodies(L3)

Text Book(s):

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1/e, 2015.
3. M. P. Jain, Indian Constitution Law, 7/e, Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes

After successful completion of the course, the student will be able to

- describe the philosophy and salient features of Indian constitution(L2)
- list the constitutional rights and duties of a citizen(L1)
- elaborate the central and local administrative hierarchy and their roles(L2)
- describe the roles/responsibilities/powers of different governing and administrative bodies(L2)
- explain the structure/functioning and power of election commission(L2)

19EAC746: PEDAGOGY STUDIES

L	T	P	C
2	0	0	0

This course is aimed to familiarizing the student with pedagogical principles, practices and methodologies. This course is intended for students interested in pursuing a career in teaching and research.

Course Objectives

- to familiarize the student about the need for pedagogy studies, background and conceptual framework
- to expose the student to pedagogical practices in formal/informal classrooms
- to acquaint the student with type of curriculum and guidance materials for effective pedagogy
- to familiarize the student with classroom practices and curriculum assessment procedures
- to make the student understand the effect of undertaking research on teaching quality

Unit I **5L**

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the aim and rationale behind teacher education(L1)
- classify the different theories of learning (L1)
- elaborate the need and role of curriculum, teacher education (L1)

Unit II **5L**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the different pedagogical practices used by teachers in formal and informal classrooms(L1)
- explain the pedagogical practices employed in developing countries (L1)
- enumerate the duties of faculty in terms of teaching, research, consultancy, administration (L1)

Unit III **6L**

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the measures for effective pedagogy(L1)
- identify the different documentation required to formalize curriculum implementation and quality assessment(L1)
- describe the teachers attitudes and beliefs in pedagogic strategies(L2)

Unit IV **6L**

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the organizational hierarchy in a school administration system(L1)
- list the different barriers to learning(L3)
- enumerate the methods to overcome limited resources and handle large class sizes(L3)
- describe the follow-up support and peer-support in classroom practices(L2)

Unit V **6L**

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the need for and role of research in teaching profession(L2)
- list the different research activities to be taken up by teachers(L1)
- describe the impact of research on teaching quality and learning process(L2)

Text Book(s):

1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261, 2001
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, 2004.
3. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID., 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282., 2013.
5. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell., 2001.
6. Chavan M, Read India: A mass scale, rapid, 'Learning to Read' campaign., 2003.

Course Outcomes

After successful completion of the course, the student will be able to

- describe the theories of learning and conceptual framework of pedagogy(L2)
- explain the pedagogical practices used by teachers in formal and informal classrooms(L2)
- visualize the administrative hierarchy of schools and colleges and define the role(L3)
- appreciate the need for research and define the future direction of teaching career(L3)
- describe the impact of curriculum and assessment on the teaching learning process of a student(L3)

19EAC747: STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with basic principles of yoga and different physical/mental practices for managing mind and body. This course helps the student in managing stress during education, home and workplace. Further, principles learnt in this course help in building overall personality for a stress-free, happy and independent life.

Course Objectives:

- To familiarize the student about eight parts of yoga and their significance
- To expose the student to the importance and meaning of Yam and Niyam
- To make the student understand the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
- To introduce the different yogic poses with a knowledge of their benefits for mind and body
- To familiarize the effect of different types of breathing techniques in concept and in activity

Unit I 9L

Definitions of Eight parts of yoga (Ashtanga).

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the eight parts of yoga(L2).
- describe the effects of different parts of yoga on mind and body(L1).
- elaborate the importance of yoga in stress management and personality development(L3).

Unit II 9L

Yam and Niyam.
Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Learning Outcomes:

After the completion of this unit, the student will be able to

- elaborate the importance of Yam and Niyam (L2).
- describe the meaning and significance of Ahinsa, satya, astheya etc (L1).
- explain the need for shaucha, santosh, tapa, swadhyay in leading a healthy and fruitfullife (L3).

Unit III 9L

Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its Effects-Types of pranayam.

Learning Outcomes:

After the completion of this unit, the student will be able to

1. demonstrate the different physical asanas and explain their physical and phychological effects(L1).
2. demonstrate the different breathing techniques and describe their physical and mental effects (L3).
3. distinguish between different types of pranayamam(L4).

Text Books

1. Janardan, Yogic Asanas for Group Tarining-Part-I, Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature", Advaita Ashrama, Kolkata

Course Outcomes:

After successful completion of the course, the student will be able to

- describe the eight parts of yoga and their significance (L1).
- explain the the importance and meaning of Yam and Niyam (L3).
- define the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc (L2).
- demonstrate the different yogic poses and explain their benefits for mind and body (L4).
- demonstrate the different types of breathing techniques and explain their physical and mental benefits (L5).

19EOE742: BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

This course introduces students to the science of business analytics. The goal is to provide students with the foundation needed to apply data analytics to real-world challenges they confront daily in their professional lives. Students will learn to identify the ideal analytic tool for their specific needs; understand valid and reliable ways to collect, analyze, and visualize data; and utilize data in decision making for managing agencies, organizations or clients in their workspace

Course Objectives

- To familiarize the scope, process and advantages of business analytics
- To acquaint the student with the modeling and problem solving skills in business analytics
- To impart the organization and management of business analytics
- To introduce the forecasting models and techniques used in analytics
- To expose the formulation and decision strategies used in business analytics

Unit I **8L**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

Learning Outcomes

After the completion of this unit, the student will be able to

- define the scope and process of business analytics (L1)
- choose an organizational structure to implement a business analytics process (L4)
- describe the statistical tools and methods used for data modeling and analysis (L2)
- identify the sampling and estimation requirements for data analysis (L1)

Unit II **8L**

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Learning Outcomes

After the completion of this unit, the student will be able to

- identify the relationships and trends in data (L1)
- utilize linear regression methods for identifying data relationships (L4)
- list the types of data and their models used for business analytics (L1)
- describe the methods for visualization and exploration of data (L2)

Unit III **8L**

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

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the management issues in the organization structures (L2)
- define the designing information policy and its usage (L1)
- list the methods for ensuring data quality measuring contribution (L1)

- explain the use of data mining methodologies for predictive analytics analysis (L3)
- describe the use of prescriptive analytics methods in business analytics process (L2)

Unit IV **10L**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Learning Outcomes

After the completion of this unit, the student will be able to

- classify and describe the use of forecasting models (L3)
- model the use of regression forecasting with casual variables (L5)
- identify the appropriate forecasting model for a given data (L5)
- explain the use of monte carlo simulation for forecasting and identify the involved risk (L2)

Unit V **8L**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Learning Outcomes

After the completion of this unit, the student will be able to

- formulate decision problems (L2)
- list the decision strategies with and without probabilities (L1)
- use the decision trees for analysis (L4)
- describe the value of information, utility and its use in decision making (L4)

Textbook(s):

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications Pearson FT Press, 2014.
2. James Evans, Business Analytics, Pearson Education, 2013.

Course Outcomes

Upon successful completion of the course, the student will be able to

- define the scope, process and advantages of business analytics (L1)
- explain the modeling and problem solving skills in business analytics (L2)
- describe the organization and management of business analytics (L3)
- utilize the forecasting models and techniques used in analytics (L4)
- enumerate and utilize the formulation and decision strategies (L2)

19EOE744: INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

Safety by design or prevention through design is in the core for maintaining engineering systems safe. The students will be equipped with concepts of engineering systems safety, dimensions of engineering systems safety, safety design and analysis mathematics, design for engineering systems safety and control for safety, and integrating safety with other operational goals such as quality and reliability

Course Objectives

- to impart knowledge on different facets and aspects of industrial systems safety
- to familiarize the student with tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings
- to impart the knowledge of definition, function and types of maintenance activities
- to familiarize the different wear and corrosion mechanisms and their prevention methods
- to expose the students to different faults and their tracing mechanisms
- to impart the art of planning periodic and preventive maintenance mechanisms

Unit I **8L**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the different types of mechanical and electrical hazards in industrial systems(L1)
- enumerate the salient points of factories act 1948(L2)
- describe the health and safety measures to be enforced for industrial safety(L3)
- elaborate the different fire prevention and firefighting arrangements to be made(L2)

Unit II **8L**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning and aim of maintenance engineering(L1)
- elaborate the primary and secondary functions of maintenance department(L2)
- classify the different types and applications of maintenance(L3)
- relate the replacement economy with maintenance cost(L5)
- estimate the service life of equipment from the specifications of individual components(L4)

Unit III **8L**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- elaborate the different methods for reducing wear(L2)
- list the different types of lubricants and mention their applications(L1)
- define the principle and factors affecting corrosion(L1)
- classify the different types of corrosion and identify their prevention methods(L3)

Unit IV **8L**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- use the concept of decision tree for fault tracing in machine tools(L4)
- build decision trees for different machine tools including pump, air compressor etc(L4)
- classify the different types of faults in machine tools and their causes(L3)

Unit V **10L**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the concept of periodic inspection and its need(L2)
- list the common troubles and remedies of electric motor(L1)
- define the need for preventive maintenance and list its steps(L3)
- elaborate the steps/procedure of periodic and preventive maintenance of diesel generating sets, pumps etc(L2)

Text Book(s):

1. Lindley R. Higgins, Lester Coridon Morrow, Maintenance Engineering Handbook, Da Information Services, 1977.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987.
3. Audels, Pump-hydraulic Compressors, Mc Graw Hill Publication, 1992.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975

Course Outcomes

Upon successful completion of the course, the student will be able to

- describe the different facets and aspects of industrial systems safety(L2)
- demonstrate the use of tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings(L4)
- define the function and list the types of maintenance activities(L1)
- describe the concept of wear and corrosion mechanisms and their prevention methods(L2)
- enumerate the different faults and their tracing mechanisms (L3)
- elaborate the planning periodic and preventive maintenance mechanisms needed for industrial safety(L4)

19EOE746: OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.

Course Objectives

- to impart knowledge on developing mathematical formulation for linear programming and transportation problem
- to familiarize the student in the construction of the required activities in an efficient manner to complete it on or before a specified time limit and at the minimum cost.
- to expose the development of mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
- to illustrate PERT and CPM techniques for planning and implementing projects.
- To impart the knowledge of formulating and analysis of real life problems using advanced tools and techniques for resource optimization
- to provide frameworks for analyzing waiting lines using advanced queuing theory concepts

Unit I **8L**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Learning Outcomes

After completing this unit, the student will be able to

- identify and develop operational research models from the verbal description of the real system. **[L4]**
- understand the classification systems of effective Inventory control models**[L2]**

Unit II **8L**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Learning Outcomes

After completing this unit, the student will be able to

- translate a real-world problem, given in words, into a mathematical formulation. **[L2]**
- utilize the mathematical tools that are needed to solve optimization problems. **[L2]**

Unit III **8L**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Learning Outcomes

After completing this unit, the student will be able to

- describe the need and origin of the optimization methods**[L2]**
- classify optimization problems to suitably choose the method needed to solve the particular type of problem**[L3]**

Unit IV **8L**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Learning Outcomes

After completing this unit, the student will be able to

- choose linear programming problems to suitably choose the method needed to solve the particular type of problem**[L1]**
- identify industrial problems involved in inventory, MRP and scheduling**[L2]**

Unit V **8L**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Learning Outcomes

After completing this unit, the student will be able to

- identify the values, objectives, attributes, decisions, uncertainties, consequences, and trade-offs in a real decision problem**[L2]**
- Apply the models to incorporate rational decision-making process in real life situations.**[L3]**
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation.. **[L3]**

Text Book(s):

1. H.A. Taha, Operations Research, An Introduction, Prentice Hall of India, 2008
2. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, 2008
4. Hitler Libermann Operations Research: McGraw Hill Publishers, 2009
5. Pannerselvam, Operations Research: Prentice Hall of India, 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India, 2010

Course Outcomes

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

- Understand the basic concepts of different advanced models of operations research and their applications. (L2)
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action. (L4)
- Apply the models to incorporate rational decision-making process in real life situations. (L4)
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation. (L3)
- Validate output from model to check feasibility of implementations. (L5)
- Create innovative modeling frameworks for a given situation. (L6)
- Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship. (L3)

19EOE752: WASTE TO ENERGY

L	T	P	C
3	0	0	3

This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements.

Course Objectives

- to introduce the classification of waste for its usefulness in preparing different fuels
- to familiarize the biomass pyrolysis process and its yield issues
- to acquaint the student with biomass gasification processes and construction arrangements
- to impart the types and principles of biomass combustors
- to familiarize the calorific values and composition of biogas resources

Unit I **8L**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Learning Outcomes

After the completion of this unit, the student will be able to

- distinguish between different types of waste (L1)
- classify the different types of waste for manufacturing different types of fuel (L3)
- identify the different conversion devices and their applications(L4)

Unit II **8L**

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Learning Outcomes

After the completion of this unit, the student will be able to

- classify the different types of pyrolysis methods based on speed(L1)
- describe the different methods of manufacturing charcoal (L2)
- explain the chemical processes involved in the manufacture of pyrolytic oils and gases(L2)

Unit III **8L**

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the design, construction and operation of different gasifiers(L2)
- describe the burner arrangement for thermal heating(L2)
- elaborate the gasifier engine arrangement for equilibrium and kinetic considerations(L3)

Unit IV **8L**

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the basic principle of biomass combustors(L2)
- classify different combustors based on their capacity and efficiency(L3)
- describe the construction and operation of fixed bed inclined grate, fluidized bed combustors (L2)

Unit V **10L**

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the properties of biogas(L1)
- elaborate the design, construction and operation of biogas plant(L2)
- classify the different biomass resources and their conversion process(L3)
- distinguish between different biogas plants and identify their applications(L5)

Text Book(s)

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Outcomes

After the successful completion of the course, the student will be able to

- classify different types of waste for their usefulness in preparing different fuels(L3)
- describe the biomass pyrolysis process and its yield issues(L2)
- outline the different biomass gasification processes and their construction arrangements(L3)
- explain the types and principles of biomass combustors(L2)
- analyze the calorific values and composition of biogas resources(L5)

19EEE792: TECHNICAL SEMINAR

L	T	P	C
0	0	4	2

Scope & Overview: Each student shall survey a technical topic related to a chosen specialization and prepare/submit a report in a specified format. It is advisable for students to choose a topic of interest to be continued as M.Tech Project in the 3rd & 4th Semester. The guidelines to carry out the research shall include the following:

1. Literature Review
2. Identification of Gap
3. Objectives and Expected Outcomes
4. Methodology / Innovative solution

Each student has to prepare a power point presentation on a selected technical topic with a novelty and get it evaluated by the faculty assigned for this purpose.

19EEE891: PROJECT WORK I

L	T	P	C
0	0	26	13

Each student is required to submit a report of first part of project work i.e. about the problem definition, literature review and methodology to be adopted including experiments and tests to be performed on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester end.

19EEE892: PROJECT WORK II

L	T	P	C
0	0	26	13

Each student is required to submit a detailed project report about the work on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester and Final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time. The candidate shall present/publish one paper in national/international conference/seminar/journal of repute. However candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.