UNIVERSITY OF DELHI

NETAJI SUBHAS INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

SCHEME OF COURSES

FOR

M.TECH

(INDUSTRIAL ELECTRONICS)

TABLE OF CONTENTS

PREAMBLE

I. INTRODUCTION

Higher education is very important for the growth and development of any country. It is a living organ and requires continuous changes to ensure the quality of education. National Knowledge Commission and University Grants Commission have recommended many academic reforms to address the challenges of today's networked globalized world. People are coming together with the help of new technologies which is resulting towards new aspirations, expectations, collaborations and associations. The concept of "work in isolation" may not be relevant and significant anymore. The UGC guidelines on adoption of Choice Based Credit System may be an important step to revamp the processes, systems and methodologies of Higher Educational Institutions (HEIs). The teacher centric mode be changed to learner centric mode. Class room teaching and learning be made effective; relevant and interesting. Concepts and theories be explained with examples, experimentation and related applications.

A culture of discussions, arguments, interpretations, counter-interpretations, re-interpretations, and opposing interpretations must be established. Research should not only be confined to redefinition, extension and incremental change. Innovation & creativity should become an epicenter for all research initiatives. The most important capital is the human capital and thus the ultimate objective is to develop good human beings with utmost integrity & professionalism for this new world.

The Choice Based Credit System supports the grading system which is considered to be better than conventional marks system. It is followed in many reputed institutions in India and abroad. The uniform grading system facilitates student mobility across the institutions within and across the countries and also enable potential employers to assess the performance of the students. The Choice Based Credit System makes the curriculum interdisciplinary and bridge the gap between professional and liberal education.

II. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions have been moving from the conventional annual system to semester system. Currently many of the institutions have already introduced the choice based credit system. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. It is desirable that the HEIs move to CBCS and implement the grading system.

A. Types of Courses

Courses are the subjects that comprise the M.Tech. programme.

1. A course may be designed to comprise lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva, seminars, term papers, assignments, presentations, self-studyetc.ora combination of some of these components.

2. The learning OUTCOMESS and learning OUTCOMESs of each course will be defined before the start of a semester.

3. Courses are of two kinds: Core and Elective.
   i. **Core Course (CC)**: This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirement of B.E.

ii. **Elective Course**: An elective course is a course which can be chosen from a pool of subjects. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency/skill. An elective may be of following types:

a) **Discipline Centric Elective (ED)**: It is an elective course that adds proficiency to the students in the discipline.

b) **Open Elective (EO):** It is an elective course taken from other engineering disciplines that broadens the perspective of an Engineering student.

4. Each course contributes certain credits to the programme. A course can be offered either as a full course (4 credits) or as a half course (2 credits). A full course is conducted with 3 hours of lectures and either 1 hour of tutorial or 2 hours of practical work per week. A half course is conducted with 2 hours of lectures.

5. A student of Postgraduate programme has to accumulate about 40% credits from the Core Courses and the remaining credits from the Elective Courses to become eligible for the award of degree/ diploma/ certificate programmes.

6. A course (full/half) may also be designed without lectures or tutorials. However, such courses may comprise Field work, Outreach activities, Project work, Vocational Training, Seminars, Self-study etc. or a combination of some of these.

7. A Project work/ Dissertation is considered as a special course involving application of the knowledge gained during the course of study in exploring, analyzing and solving complex problems in real life applications. A candidate completes such a course on his own with an advisory support by a teacher/faculty member.

B. Examination and Assessment

The following system will be implemented in awarding grades and CGPA under the CBCS system.

1. **Letter Grades and Grade Points:** A 10-pointgradingsystem shall be used with the letter grades as given in Table 1 below:

Table1: Grades and Grade Points

Letter Grade	Grade point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (absent)	0

2. **Fail grade:** A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. If the student does not want to reappear in an elective subject (that is ED, EO *but not CC courses*) then he/she can re-register afresh for a new elective subject.

3. **Non-credit course:** For non credit courses, 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA. However, a student must get satisfactory to get the degree.
4. **Fairness in Assessment:** The CBCS promotes continuous evaluation system where end semester examinations weightage should not be more than 60%. The Departments should design their own methods for continuous evaluation. They have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi & teaching, learning methods. In this regard, the checks and balances be implemented which enable Departments would effectively and fairly carry out the process of assessment and examination.
5. **Computation of SGPA and CGPA:** The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):
   i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$\text{SGPA}(S_i) = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

   Where C_i is the number of credits of the i^{th} course and G_I is the grade point scored by the student in the i^{th} course.

   ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$\text{CGPA} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

   Where S_i is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

   iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

   iv. CGPA shall be converted into percentage of marks, if required, by multiplying CGPA by 10.

III. PROGRAMME STRUCTURE

1. The M.Tech. Industrial Electronics program IE full time (FT) spans 4 semesters, normally completed in 2 years, while M.Tech. Industrial Electronics program IE part time (PT) spans 6 semesters, normally completed in 3 years.
2. The courses offered in each semester are given in the **Semester-wise Course Allocation.**
3. The discipline centric subjects under CC and ED categories are listed for each discipline separately.
4. A course may have pre-requisite courses that are given in the **Semester-wise Course Allocation**. A student can opt for an elective only if he/she has fulfilled its pre-requisites.
5. A student has to register for all electives before the start of a semester.

IV. COURSE CODIFICATION

The codes for various Postgraduate Programme are as follows:

i. Department of Electronics and Communication Engineering: EC

   1. Signal Processing-ECSP
   2. Embedded System and VLSI-ECES

ii. Department of Computer Engineering:

1. Information System-COIS

iii. Department of Instrumentation and Control Engineering: IC

1. Process Control-ICPC
2. Industrial Electronics-ICIE
3. Mechatronics-ICMT
4. Biomedical Instrumentation-ICBI

iv. Department of Biotechnology: BT

1. Biochemical Engineering -BTBC
2. Bioinformatics-BTBF

v. Manufacturing processes and Automation Engineering: MPAE

1. CAD CAM-MACD
2. Manufacturing process and Automation Engineering.-MAMP
3. Production Engineering-MAPE
4. Engineering Management- MAEM
5. Nanotechnology- MANT

The codes for Departmental core subjects and Domain-specific Electives are specific to each Discipline. The first two characters are derived from Departmental codes listed above.

For Ist semester, the codes are:

IEC01	CC
IEC02	CC
IED**	Elective
IED**	Elective
IED**	Elective
EO***	Open Elective

For IInd semester, the codes are:

IEC03	CC
IEC04	CC
IED**	Elective
IED**	Elective
IED**	Elective
EO***	Open Elective

For IIIrd semester, the codes are:

IED**	Elective
IED**	Elective

IED**	Elective
IEC05	Seminar
IEC06	Major Project

For IVth semester, the codes are:

IEC07	Dissertation

V. EVALUATION SCHEME

The courses are evaluated on the basis of continuous assessments, mid-semester exams and end-semester exams. The weightage of each of these modes of evaluation for the different types of courses are as follows.

Type of Course	**CA**	**Mid Semester Exam (Theory)**	**End-semester Exam (Theory)**	**Continuous Assessment (Lab)**	**End-semester Exam (Lab)**
CC/ED/EO Theory with Tutorial	25	25	50	Nil	Nil
CC/ED/EO Theory with Practical	15	15	40	15	15
Major Project and Dissertation	Nil	Nil	Nil	40	60

VI. DECLARATION OF RESULTS

1. The M.Tech (IE) programme consists of 82 credits. A student will be awarded the degree if he/she has earned all 82 credits.
2. CGPA will be calculated on the basis of the best 78 credits earned by the student.
3. The candidate seeking re-evaluation of a course shall apply for the same on a prescribed Performa along with the evaluation fee prescribed by the university from time to time only for the End Semester Examination within seven days from the date of declaration of result.
4. The Institution/University may cancel the registration of all the courses in a given semester if
   i. The student has not cleared the dues to the institution/hostel.
   ii. A punishment is awarded leading to cancellation of the student's registration.

VII. EVALUATION AND REVIEW COMMITTEE

The Committee of Courses and Studies in each department shall appoint one or more Evaluation-cum-Review Committees (ERC), each committee dealing with one course or a group of courses. This ERC consists of all faculty members who are likely to teach such courses in the group. Normally Head of the department shall be ERC Chairman.

The ERC has the following functions-

(i) To recommend appointment of paper setters/examiners of various examinations at the start of each semester.

(ii) To prepare quizzes, assignments, test papers etc. for Continuous Assessment (CA), Mid-Semester examination (MS) and End Semester (ES) examination and to evaluate them. Normally, each

concerned faculty member, who is also a member of ERC, will do this job for his/her class. However, in exceptional circumstances any part of the work may be entrusted to some other member of the ERC.

(iii) To consider the individual representation of students about evaluation and take remedial action if needed. After scrutinizing, ERC may alter the grades awarded upward/downward. The decision of the ERC shall be final.

(iv) To moderate assignments, quizzes etc. for courses given by each of the concerned faculty members for his/her class with a view to maintain uniformity of standards.

(v) To review and moderate the MS and ES results of each course with a view to maintain uniformity of standards.

(vi) To lay guidelines for teaching a course.

VIII. ATTENDANCE, PROMOTION AND DETENTION RULES

1. A student should normally attend all the classes. However, a student will be allowed to appear in the examination if he/ she has put in a minimum of 75% attendance separately in each course for which he / she has registered. A relaxation up to a maximum of 25% may be given on the production of satisfactory evidence that (a) the student was busy in authorized activities, (b) the student was ill.
2. A student should submit the evidence to the fact 1(a) and / or 1(b) above within seven working days of resuming the studies. Certificates submitted later will not be considered.
3. No relaxation in attendance beyond 25% is permitted in any case.
4. A student may re-register for a course if he/ she want to avoid a decrement in the grades.
5. There shall be no supplementary examinations. A student who has failed in a course will have to re-register for the course in a subsequent year.
6. If the student does not want to reappear in an elective course (that is, ED, EO, but not CC courses) then he/she can re-register afresh for a new elective course.

VIII. CURRICULUM MODIFICATION

The curriculum will be updated regularly within a period of 5 to 10 years since last revision, to keep pace with the advancements in the field of Biochemical Engineering.

IX. CENTRAL ADVISORY COMMITTEE

There shall be a Central Advisory Committee consisting of the following—

a) Dean, Faculty of Technology, Chairman
b) Dean PGS
c) Head of Institution
d) Heads of Departments running M.Tech Courses

X. PROGRAM EDUCATIONAL OBJECTIVE:

The major OUTCOMESS of the M.Tech. programme in Industrial Electronics are to equip the students with adequate knowledge and skills in Industrial Electronics and to prepare them for the following career options:

a) Research programs in Industrial Electronics and related areas.
b) Employment in R & D organizations related to sustainable technologies.
c) To work in Industrial electronic circuit design and fabrication industries.

d)Faculty positions in reputed institutions.

XI. PROGRAM OUTCOMES

a) A student who has undergone M.Tech. programme in Industrial Electronics (IE) will have an ability to evaluate and analyze problems related to Industrial Electronic Systems and incorporate the principles in the state of art systems for further improvement.

b) Each student will have to investigate critical IE problems and to arrive at possible solutions independently, by applying theoretical and practical considerations.

c) Each student will have to solve IE problems such as switching control, converter design, analysis and control of solid state drives and stability studies**.**

d) Each student will have to identify optimal solutions for improvising power conversion and transfer capability,

e) Each student will have enhancing power quality and reliability through IE based solutions.

f) Each student will have to evolve new power electronic topologies and control schemes based on literature survey and propose solutions through appropriate research methodologies, techniques and tools, and also by designing and conducting experiments.

g) Each student will have to work on small, well-defined projects with particular goals to provide real time solutions pertaining to Industrial electronics.

h) Each student will have to develop, choose, learn and apply appropriate techniques, various resources including sophisticated digital controllers and IT tools for modern Industrial electronic system simulation, including prediction and modelling with existing constraints.

i) Each student will have to develop dedicated software for analyzing and evaluating specific Industrial electronics and control problems.

j) Each student will have to participate in collaborative-multidisciplinary engineering / research tasks and work as a team member in such tasks related to IE domain, giving due consideration to ecological and economical intricacies, and lead the team in specific areas.

k) Each student will have to confidently interact with the industrial experts for providing consultancy.

l) Each student will have to pursue challenging professional endeavors based on acquired competence and knowledge

m) Each student will be a responsible professional with intellectual integrity, code of conduct and ethics of research, being aware of the research OUTCOMESs and serve towards the sustainable development of the society

n) Each student will be capable of examining critically the OUTCOMESs of research and development independently without any external drive.

SCHEME-SEMESTER-WISE COURSE ALLOCATION

M.TECH. INDUSTRIAL ELECTRONICS (FT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IEC01	CC	Power Converter	3	0	2	4	15	15	40	15	15	100
IEC02	CC	Industrial Control Electronics	3	0	2	4	15	15	40	15	15	100
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO**	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		TOTAL	18	3	6	24						
			$									

#. The LTP allocation evaluation scheme and Pre-requisites for electives are given in Tables 3-4
The course code will depend upon student's choice of elective.
$. The actual weekly load will depend upon the electives chosen by the student.

M.TECH. INDUSTRIAL ELECTRONICS (FT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IEC03	CC	Switched Mode Power Converter	3	0	2	4	15	15	40	15	15	100
IEC04	CC	Power Electronic Drives	3	0	2	4	15	15	40	15	15	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		TOTAL	18	3	6	24						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. INDUSTRIAL ELECTRONICS (FT) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100

IEC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
IEC06	CC	Major Project	0	0	-	6				40	60	100
		TOTAL	6	1	-	20						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. INDUSTRIAL ELECTRONICS (FT) SEMESTER IV

CODE	**COURSE OF STUDY**	**L**	**T**	**P**	**C**	**EVALUATION SCHEME Percentage (Weightage)**					
						Theory			**Practical**		**Total**
						CA	**MS**	**ES**	**Int.**	**Ext**	
IEC07	Dissertation	0	0	-	14	-	-	-	40	60	100
	TOTAL	0	0	-	14						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

SCHEME-SEMESTER-WISE COURSE ALLOCATION-PART-TIME

M.TECH. PROCESS CONTROL (PT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IEC01	CC	Power Converter	3	0	2	4	15	15	40	15	15	100
IEC02	CC	Industrial Control Electronics	3	0	2	4	15	15	40	15	15	100
EO**	EO	Open Elective I#	3	1	0	4	25	25	50	-	-	100
		TOTAL	9	1	4	12						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. PROCESS CONTROL (PT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IEC03	CC	Switched Mode Power Converter	3	0	2	4	15	15	40	15	15	100
IEC04	CC	Power Electronic Drives	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective II#	3	1	0	4	25	25	50	-	-	100
		TOTAL	9	1	4	12						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. PROCESS CONTROL (PT) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	-	-	-	12						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).

$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. PROCESS CONTROL (PT) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	9	2	2	12						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. PROCESS CONTROL (PT) SEMESTER V

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IED**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
IED**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
IEC05	CC	Major Project	0	0	-	6				40	60	100
		TOTAL	6	1	2	14						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. PROCESS CONTROL (PT) SEMESTER VI

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
IED**	ED	Elective	-	-	-	4	-	-	-	-	-	100
IEC06	CC	Seminar	0	0	4	2	100	-	-	-	-	100
IEC07	CC	Dissertation	0	0	-	14	-	-	-	40	60	100
		TOTAL	0	0	4	20						

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 3-4. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

Table 3: LIST OF DISCIPLINE CENTRIC ELECTIVES

CODE	COUSRE OF STUDY	PREREQUISITE	L	T	P	C
IED01	Optimization Techniques	Undergraduate level mathematics	3	1/0	0/2	4
IED02	Advanced Power System Analysis	Power System analysis	3	1/0	0/2	4
IED03	Flexible AC Transmission Systems	Power System Analysis, Power Conversion techniques	3	1/0	0/2	4
IED04	Electrical Distribution Systems	Transmission and Distribution	3	1/0	0/2	4
IED05	PWM Converters And Applications	____	3	1/0	0/2	4
IED06	Advanced power apparatus	Power Apparatus	3	1/0	0/2	4
IED07	Design of hydropower system	____	3	1/0	0/2	4
IED08	Advanced Power System Protection	short circuit analysis, digital system and signal processing	3	1/0	0/2	4
IED09	High Voltage DC Transmission	Power Electronics, Power System	3	1/0	0/2	4
IED10	Power quality and harmonics	Power Quality	3	1/0	0/2	4
IED11	Advanced Topics in Power Electronics	Power Electronics	3	1/0	0/2	4
IED12	Power apparatus design	Power Apparatus	3	1/0	0/2	4
IED13	Modeling and Analysis of Electrical machines	Power Apparatus	3	1/0	0/2	4
IED14	Renewable Power Generation Technologies	Power Apparatus	3	1/0	0/2	4
IED15	Power System Operation And Control	Power Systems	3	1/0	0/2	4
IED16	Micro Controller Applications in Power converters	Power Electronics and microprocessor	3	1/0	0/2	4
IED17	Smart Grid Technologies	Power Systems	3	1/0	0/2	4
IED18	Electric Systems in Wind Energy	Electric Machines	3	1/0	0/2	4
IED19	Distributed Generation and Micro-grid	Power System	3	1/0	0/2	4

IED20	Microcontroller Applications In Power Converters	Power Electronics	3	1/0	0/2	4
IED21	Power System Planning And Reliability	Power System	3	1/0	0/2	4
IED22	Control Design Techniques for Power Electronic Systems	Control System and Power Electronics	3	1/0	0/2	4
IED23	Electric and Hybrid Vehicles	Power Apparatus	3	1/0	0/2	4
IED24	Energy Storage Systems Energy Auditing and Management	Fundamental Chemistry and material science	3	1/0	0/2	4
IED25	Embedded Processors and Controllers	---	3	1/0	0/2	4
IED26	Computer Relaying And Wide Area Measurement Systems	---	3	1/0	0/2	4
IED27	Transient over Voltages in Power Systems	Engg Mathematics and Power systems	3	1/0	0/2	4
IED28	Digital Simulation of Power Electronic Systems	Power Electronics	3	1/0	0/2	4
IED29	Neural networks in embedded applications	Microprocessor	3	1/0	0/2	4
IED30	Fault Detection And Diagnosis	Engineering Mathematics	3	1/0	0/2	4
IED31	Intelligent Control	---	3	1/0	0/2	4
IED32	Reactive Power Control & Facts Devices	Power Electronics	3	1/0	0/2	4
IED33	Soft Computing	---	3	1/0	0/2	4
IED34	Energy Auditing	---	3	1/0	0/2	4
IED35	Virtual Instrument Design	Transducers , measurements	3	1/0	0/2	4
IED36	Non Linear System Control using Neural and Fuzzy Reinforcement Learning	---	3	1/0	0/2	4
IED37	Design techniques for SMPs	---	3	1/0	0/2	4

Table 4: LIST OF OPEN ELECTIVES EO-*

LTP Allocation			Evaluation Scheme				
L	**T**	**P**	**CA**	**MS**	**ES**	**Int**	**Ext**
3	**1**	**0**	**25**	**25**	**50**	**-**	**-**
Code	**Name of Elective**		**Pre-Requisites**				
EO001	Technical Communication		None				
EO002	Disaster Management		None				
EO003	Basics of Finance Management		None				
EO004	Basics of Human Resources Management		None				
EO005	Project Management		None				
EO006	Basics of Corporate Law		None				
EO007	Biological computing		None				
EO008	Sociology		None				
EO009	Entrepreneurship		None				
EO010	Social work		None				
EO011	IP and Patenting		None				
EO012	Supply Chain Management-Planning and logistics		None				
EO013	Organization Development		None				
EO014	Industrial Organization and Managerial Economics		None				
EO015	Global Strategy and Technology		None				
EO016	Engineering System Analysis and Design		None				
EO017	Biology for Engineers		None				
EO018	Energy, Environment and Society		None				
EO019	Public Policy and Governance		None				

Course Content of Core Courses and Discipline Centric Electives

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IEC01	**POWER CONVERTERS**	**4**	**3-0-2**	Power Electronics in UG

COURSE OUTCOMES (CO):

- To give a systematic approach for transient and steady state analysis of all power electronic converters with passive and active loads.
- The student will be able to comprehensively understand and carry out transient and steady state analysis of different power converters of different types of loads and switching sequences.

COURSE CONTENTS:

Analysis of power semiconductor switched circuits with R, L, RL, RC loads, d.c.motor load, battery charging circuit. Single-Phase and Three-Phase AC to DC converters- half controlled configurations-operating domains of three phase full converters and semi-converters – Reactive power considerations.

Analysis and design of DC to DC converters- Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters.

Single phase and Three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters.

AC to AC power conversion using voltage regulators, choppers and cyclo-converters, consideration of harmonics, introduction to Matrix converters.

SUGGESTED READINGS:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John’s Wiley and sons. Inc, New york.
2. Rashid M.H., “Power Electronics-Circuits, Devices and Applications”, Prentice Hall India, New Delhi.
3. P.C Sen., “Modern Power Electronics”, Wheeler publishing Company, New Delhi.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IEC02	INDUSTRIAL CONTROL ELECTRONICS	4	3-0-2	Fundamental knowledge about analog, digital and Power electronic circuits.

COURSE OUTCOMES (CO):

- This course gives a comprehensive coverage of various control electronics used in the industries. This combines the analog and digital concepts together with Power Electronics for the design of the controllers. Further an overview of stepper motor and servomotor with associated control circuits is given.
- The students will be able to design and analyze analog controllers for UPS, Switching regulators and inverters. Further they will be able to design opto-electronic controllers for various applications. They will have complete knowledge about signal conditioning circuits and industrial applications of stepper motor and servomotor.

COURSE CONTENTS:

Review of switching regulators and switch mode power supplies, Uninterrupted power supplies- off-line and on-line topologies-Analysis of UPS topologies, solid state circuit breakers, solid-state tap-changing of transformer

Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers

Derivative overrun, integral windup, cascaded control, Feed forward control, Digital control schemes, control algorithms, programmable logic controllers.

Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding.

Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors; Fibre-optics; Bar code equipment, application of barcode in industry.

Stepper motors – types, operation, control and applications; servo motors- types, operation, control and applications – servo motor controllers – servo amplifiers – linear motor applications-selection of servo motor.

SUGGESTED READINGS:

1. Michael Jacob, “Industrial Control Electronics – Applications and Design”, Prentice Hall.
2. Thomas E. Kissell, “Industrial Electronics”, Prentice Hall India.
3. James Maas, “Industrial Electronics”, Prentice Hall.
4. M.D. Singh and K. B. Khanchandani, “Power Electronics”, Tata McGraw-Hill.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IEC03	SWITCHED MODE POWER CONVERSION	4	3-0-2	Power Converters

COURSE OUTCOMES (CO):

- Understand the concepts, basic operation, steady-state operation of efficient switched-mode power conversion techniques, including basic circuit operation and magnetic design.
- After taking this course students will be able to do the Steady-State Analysis,
- modeling, design of switched-mode dc-dc power converters and corresponding control techniques. Become proficient with computer skills (e.g., PSPICE and MATLAB) for the analysis and design of switched-mode power converters.

COURSE CONTENTS:

Design constraints of reactive elements in Power Electronic Systems: Design of inductor, transformer and capacitors for power electronic applications, Input filter requirement.

Basic concepts and steady-state analysis of second and higher order Switched Mode power converters: PWM DC - DC Converters (CCM and DCM) - operating principles, constituent elements, characteristics, comparisons and selection criteria.

Dynamic Modeling and control of second and higher order switched Mode power converters: analysis of converter transfer functions, Design of feedback compensators, current programmed frequency programmed and critical conduction mode control.

Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current-switching converters, Multi-resonant converters and Load resonant converters.

Pulse Width Modulated Rectifiers: Properties of ideal rectifier, realization of near ideal rectifier, control of the current waveform, single phase and three-phase converter systems incorporating ideal rectifiers and design examples.

Non-linear phenomena in switched mode power converters: Bifurcation and Chaos.

SUGGESTED READINGS:

1. Robert W. Erickson and Dragan Maksimovic, “Fundamentals of Power Electronics”, Springer.
2. Marian K. Kazimierczuk, “Pulse-width Modulated DC-DC Power Converters”, John Wiley & Sons.
3. Philip T Krein, “Elements of Power Electronics”, Oxford University Press.
4. Batarseh, “Power Electronic Circuits”, JohnWiley.
5. H. W. Whittington, B. W. Flynn, D. E. Macpherson, “Switched Mode Power Supplies”, John Wiley & Sons Inc.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IEC04	**POWER ELECTRONIC DRIVES**	**4**	**3-0-2**	A course in Power Electronics and electrical machines.

COURSE OUTCOMES (CO):

- To introduce basic concepts of load and drive interaction, speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects, design methodology.
- The student will be able to analyze, simulate and evaluate performance of variable speed drives.

COURSE CONTENTS:

Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive.

Conventional methods of D.C. motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation.

Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.

Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Voltage source and Current source inverter fed induction motor drives.

Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines.

SUGGESTED READINGS:

1. P.C Sen, “Thyristor DC Drives”, John Wiley and Sons.
2. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt Ltd.
3. Bimal K.Bose, “Modern Power Electronics and AC Drives”, Pearson Education (Singapore) Pvt. Ltd.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED01	**OPTIMIZATION TECHNIQUES**	**4**	**3-0-2**	Undergraduate level mathematics

COURSE OUTCOMES (CO):

- To learn essential optimization techniques for applying to day to day problems.
- After learning the techniques they can apply to engineering and other problems.

COURSE CONTENTS:

Linear programming – formulation - Graphical and simplex methods - Big-M method - Two phase method - Dual simplex method - Primal Dual problems.

Unconstrained one dimensional optimization techniques - Necessary and sufficient conditions – Unrestricted search methods - Fibonacci and golden section method - Quadratic Interpolation methods, cubic interpolation and direct root methods.

Unconstrained n dimensional optimization techniques – direct search methods – Random search – pattern search and Rosen brock's hill climbing method - Descent methods - Steepest descent, conjugate gradient, quasi - Newton method

Constrained optimization Techniques - Necessary and sufficient conditions – Equality and inequality constraints - Kuhn-Tucker conditions - Gradient projection method - cutting plane method – penalty function method.

Dynamic programming - principle of optimality - recursive equation approach - application to shortest route, cargo - loading, allocation and production schedule problems

SUGGESTED READINGS:

1. Rao S.S., "Optimization :Theory and Application" Wiley Eastern Press.
2. Taha,H.A., "Operations Research –An Introduction, Prentice Hall of India".
3. Fox, R.L., "Optimization methods for Engineering Design", Addition Wiely.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED02	**ADVANCED POWER SYSTEM ANALYSIS**	**4**	**3-0-2**	A basic knowledge on the subjects' viz., Power System analysis, Matrix manipulations, Alternating machines and network analysis.

COURSE OUTCOMES (CO):

- To perform steady state analysis and fault studies for a power system of any size and also to explore the nuances of estimation of different states of a power system.
- On completion of the course, the students will be able to investigate the state of a power system of any size and be in a position to analyze a practical system both under steady state and fault conditions. Also the students would be able to determine the operating condition of a system according to the demand without violating the technical and economic constraints.

COURSE CONTENTS:

Network modeling – Single phase and three phase modeling of alternators, transformers and transmission lines, Conditioning of Y Matrix –- Incidence matrix method, Method of successive elimination, Triangular factorization Load flow analysis - Newton Raphson method, Fast Decoupled method, AC-DC load flow – Single and three phase methods – Sequential solution techniques and extension to multiple and multi-terminal DC systems.

Fault Studies -Analysis of balanced and unbalanced three phase faults – fault calculations – Short circuit faults – open circuit faults

System optimization - strategy for two generator systems – generalized strategies – effect of transmission losses - Sensitivity of the objective function - Formulation of optimal power flow-solution by Gradient method-Newton's method

State Estimation – method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation

SUGGESTED READINGS:

1. Grainger, J.J. and Stevenson, W.D. "Power System Analysis", Tata McGraw hill.
2. Hadi Saadat, "Power System Analysis", Tata McGraw hill.
3. Arrillaga, J and Arnold, C.P., "Computer analysis of power systems", John Wiley and Sons.
4. Pai, M.A., "Computer Techniques in Power System Analysis", Tata McGraw Hill.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED03	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**4**	**3-0-2**	Power System Analysis, Power Conversion techniques.

COURSE OUTCOMES (CO):

- This course introduces the application of a variety of high power-electronic controllers for active and reactive power in transmission lines. Students are exposed to the basics, modeling aspects, control and scope for different types of FACTS controllers.
- The students shall be able to explain the basic principles of different types of FACTS controllers and their characteristics. Also they shall be able to model different FACTS controllers, form a basis for selecting a particular controller for a given application and analyze and compare the performance of various FACTS controllers.

COURSE CONTENTS:

Fundamentals of ac power transmission - transmission problems and needs - emergence of FACTS-FACTS control considerations - FACTS controllers

Principles of shunt compensation – Variable Impedance type & switching converter type - Static Synchronous Compensator (STATCOM) configuration - characteristics and control

Principles of static series compensation using GCSC, TCSC and TSSC – applications - Static Synchronous Series Compensator (SSSC)

Principles of operation – Steady state model and characteristics of a static voltage regulators and phase shifters - power circuit configurations

UPFC - Principles of operation and characteristics - independent active and reactive power flow control - comparison of UPFC with the controlled series compensators and phase shifters.

SUGGESTED READINGS:

1. Song, Y.H. and Allan T. Johns, “Flexible AC Transmission Systems (FACTS)”, Institution of Electrical Engineers Press.
2. Hingorani ,L.Gyugyi, “Concepts and Technology of Flexible AC Transmission System”, IEEE Press New York.
3. Mohan Mathur R. and Rajiv K.Varma , “Thyristor - based FACTS controllers for Electrical transmissionsystems”, IEEE press, Wiley Inter science.
4. Padiyar K.R., “FACTS controllers for Transmission and Distribution systems”, New Age International Publishers.
5. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho “FACTS – Modeling and simulation Power Networks”, John Wiley & Sons.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED04	**ELECTRICAL DISTRIBUTION SYSTEMS**	**4**	**3-0-2**	Transmission and Distribution of Electrical Energy Power System Analysis.

COURSE OUTCOMES (CO):

- To explain the principles of design and operation of electric distribution feeders and other components
- To make the students to understand the distribution system expansion planning and reliability analysis procedures.
- Students will be able to do loss calculation in distribution lines, select the protective components, planning and reliability analysis.

COURSE CONTENTS:

Industrial and commercial distribution systems – Energy losses in distribution system – system ground for safety and protection – comparison of O/H lines and under ground cable system .Network model – power flow - short circuit and loss calculations.

Distribution system - reliability analysis – reliability concepts – Markov model – distribution network reliability – reliability performance.

Distribution system expansion - planning – load characteristics – load forecasting – design concepts – optimal location of substation – design of radial lines – solution technique.

Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – loss reduction and voltage improvement.

System protection – requirement – fuses and section analyzers-over current - Under voltage and under frequency protection – coordination of protective device.

SUGGESTED READINGS:

1. Pabla, A.S., “Electrical Power Distribution System”, Tata McGraw hill.
2. Tuvar Goner, “Electrical Power Distribution System Engineering”, McGraw hill.
3. Sterling, M.J.H., “Power System Control”, Peter Peregrinus.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED05	**PWM CONVERTERS AND APPLICATIONS**	**4**	**3-0-2**	Power Converters

COURSE OUTCOMES (CO):

- Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
- Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.
- After taking this course students will be able to recognize and use the following concepts and ideas: 1. Stead-State and transient modeling and analysis of power converters with various PWM techniques.
- Analysis and Design of Control Loops for PWM power converters along with the applications like solid state drives and power quality.

COURSE CONTENTS:

AC/DC and DC/AC power conversion, overview of applications of voltage source converters, pulse modulation techniques for bridge converters.

Bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter; calculation of switching and conduction losses.

Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters; constant V/F induction motor drives.

Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation.

Active power filtering, reactive power compensation; harmonic current compensation.

SUGGESTED READINGS:

1. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John’s Wiley and Sons.
2. Erickson RW, “Fundamentals of Power Electronics”, Chapman and Hall.
3. Vithyathil. J, “Power Electronics: Principles and Applications”, McGraw Hill.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED06	**ADVANCED POWER APPARATUS**	**4**	**3-0-2**	Power Apparatus

COURSE OUTCOMES (CO):

- To explain the principles of design and operation of electric machines.
- To make the students to understand the special motors functioning.
- Students will be able to select and use the motors according to various applications.

COURSE CONTENTS:

Introduction

Review of Transformers, Induction Machines, Synchronous Machines, DC machines and their applications.

Stepper Motors

Introduction, Construction and Principle of Stepper Motors, Step Angle Types of Stepper Motors –Variable Reluctance Stepper Motors, Multi-stack VR Stepper Motor, Permanent-Magnet Stepping Motor, Hybrid Stepper Motor, Summary of the Stepper Motors, Applications. Permanent-Magnet DC Motor. Construction and Principle, Performance and Speed Control, Low-inertia DC Motors, Shell-type Low-inertia DC Motor, Printed-circuit (Disc) DC Motor- Main features, Advantages, Disadvantages and Applications. Permanent-Magnet Synchronous Motors

Construction and Performance, Applications, Synchros, Types of Synchros- Control Transmitter, Control Receiver, Control Transformer, and Control Differential, Voltage Relations, Applications of Synchros, Torque Transmission and Error Detection. Switched Reluctance Motor

Construction and Working Principle of Switched Reluctance Motor, Advantages and Disadvantages, Applications, Comparison between VR Stepper Motor and SR Motor. Servomotors. DC Servomotors, AC servomotors, Two-phase AC servomotor, Three-phase AC servomotors.

SUGGESTED READINGS:

1. P.S. Bhimbra, “Electrical Machinery”, Khanna Publishers, Delhi.
2. A. E. Fitzerald, C. Kingsley and S.D. Umans, “Electric Machinery”, Tata McGraw Hill.
3. Ashfaq Hussian, “Electrical Machines”, Dhanpat Rai & Company.
4. S. J. Chapman, “Electrical Machinery Fundamentals” McGraw Hill.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED07	**DESIGN OF HYDRO POWER STATION**	**4**	**3-0-2**	NA

COURSE OUTCOMES (CO):

- Knowledge of layout of power plant, Turbine , hydro generators
- Stability of Hydro plants

COURSE CONTENTS:

Layout & Planning of Hydro Power Plant: Introduction, layout of power house, types of hydro power schemes, stages of investigation, PFR, DPR, hydrology, water availability and water conductor system. Penstocks, types, penstock supports, trash racks. Power Potential Estimation of Hydro Power Plants: Head, dependability analysis, layout of electrical equipments in hydro power station, selection of number of units, capacity of power plant and energy generation, and economics of the hydro power plant.

Turbines: Introduction, types of hydraulic turbines and their suitability for power plant, governing of turbines, electro hydraulic governors, time constants of governors and their importance, testing of hydraulic turbines, cavitations, silt erosion. Hydro Generators: Introduction, construction and types of hydro generators, specifications of hydro generators, characteristics of hydro generators, general arrangement of water wheel generators: large horizontal shaft generators, vertical and reversible generators, low speed generators, umbrella type, brakes and jacks, losses, insulation and temperature limits, testing of generators, generator cooling and ventilation, fire protection, design of auxiliary and grounding systems, switchyard equipments, transformers and circuit breakers.

Stability of Hydro Power Plants: Special features of hydro power plant stability.

SUGGESTED READINGS:

1. J. Guthrie Brown, “Hydro Electric Engineering: Vol. I, II,III” Blackie & Son Ltd, London.
2. Nigam, “A Hand Book of Hydro Electric Engineering”, Nem Chand Publishers.
3. B.R. Gupta, “Generation of Electrical Energy”, S. Chand & Co.
4. M.V. Deshpande, “Elements of Electrical Power Station, Design”, Ah Wheeler & Co Ltd.
5. Kothari &Nagrath, “Electrical Machines”, TMH.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED08	**ADVANCED POWER SYSTEM PROTECTION**	**4**	**3-0-2**	Basic knowledge on short circuit analysis, digital system and signal processing.

COURSE OUTCOMES (CO):

- To facilitate the students understand the basic concepts and recent trends in power system protection. To enable the students design and work with the concepts of digital and numerical relaying.
- On completion of the course the students would be skilled enough to work with various type of relaying schemes used for different apparatus protection.

COURSE CONTENTS:

General philosophy of protection - Classification and Characteristic function of various protective relays-basic relay elements and relay terminology - Development of relaying scheme.

Digital Protection of power system apparatus – protection of generators – Transformer protection – magnetizing inrush current – Application and connection of transformer differential relays – transformer over current protection.

Bus bar protection - line protection - distance protection–long EHV line protection - Power line carrier protection.

Reactor protection – Protection of boosters - capacitors in an interconnected power system.

Digital signal processing – digital filtering in protection relays - numeric protection – testing Digital filtering in protection relays – digital data transmission – relay hardware – relay algorithms - Concepts of modern coordinated control system

SUGGESTED READINGS:

1. Lewis Blackburn, J., "Protective Relaying – Principles and Applications", Marcel Dekkar, INC.
2. The Electricity Training Association, "Power System Protection Vol 1-4", The IEEE.
3. C. Russeil Mason, "The art and Science of Protective Relaying", GE Publishers.
4. Arun G Padkye and James S Thorp, "Computer Relaying for Power Systems", John Wiley publications.
5. A. T. Johns and S. K. Salman, "Digital Protection for Power Systems", Peter Peregrinus Ltd., 199

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED09	**HIGH VOLTAGE DC TRANSMISSION**	**4**	**3-0-2**	Basic knowledge on Circuit theory, Control Systems and Power Electronic is sufficient to undergo the course.

COURSE OUTCOMES (CO):

- To facilitate the students understand the basic concepts and recent trends in HVDC transmission as it an upcoming area of development. To enable the students decide, design and work with the concepts of HVDC transmission.
- On completion of the course the students would be skilled enough to work with the HVDC systems, being capable of analyzing the HVDC circuits and develop exquisite interest to work in the area of HVDC transmission.

COURSE CONTENTS:

Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - economic, technical and reliability, limitations, choice of best topology for HVDC converters, types of HVDC links - monopolar, bipolar and homopolar links, Rectifier operation of Graetz circuit with and without overlap.

Inverter operation – analysis with and without overlap. Equivalent circuit model, Combined characteristics of HVDC system, basic means of control - desired features of control, power reversal

Basic controllers - Constant Ignition Angle, Constant Current and Constant Extinction Advance angle control, power control, high level controllers. Converter faults - misfire, arc through, commutation failure. D.C. Reactor design - voltage and current oscillations.

Protection issues in HVDC – DC Circuit breakers, over voltage and over current protection. Characteristic and uncharacteristic harmonics - troubles due to harmonics - harmonic filters - active and passive filters - Reactive power control of converters

Interaction between ac and dc systems. Recent trends in HVDC - VSC based HVDC – Multi-terminal HVDC systems and Hybrid HVDC systems. Back to back thyristor converter system.

SUGGESTED READINGS:

1. Padiyar, K.R., “HVDC transmission systems”, Wiley Eastern Ltd.
2. S. Rao, “EHV-AC, HVDC Transmission and Distribution Engineering”, Khanna Publications.
3. S. Kamakshaiah and V. Kamaraju, “HVDC Transmission”, Tata McGraw Hill.
4. Kimbark, E.W., “Direct Current Transmission-vol.1”, Wiley Interscience.
5. Arrilaga, J., “High Voltage Direct Current Transmission”, Peter Pereginver Ltd.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED10	Power Quality and Harmonics	4	3-0-2	Power Electronics.

COURSE OUTCOMES (CO):

- Knowledge of Performance characteristics
- Knowledge of mitigation of Harmonics

COURSE CONTENTS:

Introduction to power quality, voltage quality. Overview of power quality,

Power quality phenomena and classification of power quality issues.

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

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

Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and impact on drives.

Harmonic Mitigation: Harmonic resonance, Impedance Scan Analysis- Passive filtering. Introduction to active power filtering. Control methods for single phase APFC.

Grounding: Grounding and wiring –introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

SUGGESTED READINGS:

1. G. T. Heydt, “Electric Power Quality”, Mc Graw-Hill.
2. J. Arrillaga, B. C. Smith, N. R. Watson & A. R. Wood, “Power System Harmonic Analysis”, John Wiley & Sons, Ltd .
3. Math H. Bollen, “Understanding Power Quality Problems”, John Wiley & Sons, INC., Publication .
4. J. Arrillaga, “Power System Quality Assessment”, John Wiley & Sons.
5. IEEE standard on electrical grounding.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED11	**ADVANCED TOPICS IN POWERELECTRONICS**	**4**	**3-0-2**	Power Electronics course, high frequency magnetic, Basics of EMC

COURSE OUTCOMES (CO):

- To give an introduction to the recent developments of power electronics from components, topology, control techniques to thermal & EMC. This course drives on the application requirements of power electronics.
- The student will have introduction to recent trends in power electronics that application demands. They will get a wide knowledge on the advanced topics to choose their area of future interest.

COURSE CONTENTS:

Introduction to switches - Advanced Silicon devices - Silicon HV thyristors, MCT, BRT & EST. SiC devices - diodes, thyristors, JFETs & IGBTs. Gallium nitrate devices - Diodes, MoSFETs.

Advance converter topologies for PEE - Interleaved converters, Z-Source converters, Multi level converters (Cascaded H-Bridge, Diode clamped, NPC, Flying capacitor) Multi pulse PWM current source converters, Advanced drive control schemes.

Advances in reactive elements - Advanced magnetic material, technology and design (Powder ferrite, Amorphous, Planar designs) Advance capacitive designs (Multilayer chip capacitors, double layers for storage, Aluminum electrolytic)

Advance storage systems - Developments in battery systems, Ultra capacitors, Fly wheel energy storage, Hybrid storage systems for EV/HEV, Power management in hybrid systems, Energy storage in renewable.

Thermal engineering with EMI/EMC techniques - Advanced thermal solutions (fan cooled, liquid cooled, heat pipes, hybrid techniques) EMC techniques (Conducted, Radiated emissions & Susceptibility), System design for EMC.

SUGGESTED READINGS:

1. Andrzej M Trzynadlowski, “Introduction to Modern Power Electronics”, John’s Wiley and sons. Inc.
2. R D MiddleBrook & Slobodan CUK, “Advances in Switched Mode Power Conversion- Vol I, II, & III”, Tesla Co.
3. B. Jayant Balinga, “Advanced High Voltage Power Device Concepts”, Springer New York.
4. Bin Wu, “High Power Converters and AC Drives”, IEEE press Wiley Interscience, a John wiley& sons Inc publication.
5. Wurth Electronics, “Trilogy of Magnetics, Design guide for EMI filter design in SMPS & RF circuits”, Würth Elektronik GmbH & Company KG.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED12	**POWER APPARATUS DESIGN**	**4**	**3-0-2**	NA

COURSE OUTCOMES (CO):

- To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used.
- The students will be able to model and design all types of rotation machines including special machines. They will have complete knowledge about electromagnetic energy conversion and application of reference frame theories for modeling and designing of machines with the knowledge of dimensions and material used.

COURSE CONTENTS:

Principles of Design of Machines -

Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines.

Heating Cooling and Ventilation-

Heating and cooling of machines, types of ventilation, continuous and intermittent rating.

Design of Transformers-

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, calculation of losses, efficiency and regulation, forces winding during short circuit.

Three Phase Induction Motors-

General considerations, output equation, choice of specific electric and magnetic loadings, efficiency, power facto number of slots in stator and rotor, elimination of harmonic torques, Design of stator and rotor winding, slot leaka flux, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, efficiency from desi data.

Alternators-

Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions.

Introduction to Computer Aided Electrical Machine Design.

SUGGESTED READINGS:

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman.
3. Sawhney A.K, "A course in Electrical Machine Design", Dhanpat Rai & Sons,5th Edition.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED13	**MODELING AND ANALYSISOF ELECTRICAL MACHINES**	**4**	**3-0-2**	Electromagnetic field theory, Vector algebra and fundamentals of all electrical rotating machines.

COURSE OUTCOMES (CO):

- To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions.
- The students will be able to model all types of rotation machines including special machines. They will have complete knowledge about electromagnetic energy conversion and application of reference frame theories for modeling of machines.

COURSE CONTENTS:

Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system.

Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames,

Determination of Synchronous Machine Dynamic Equivalent Circuit Parameters, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

Special Machines - Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self controlled operation; Analysis of Switch Reluctance Motors.

SUGGESTED READINGS:

1. Charles Kingsley ,Jr., A.E. Fitzgerald, Stephen D.Umans, “Electric Machinery”, Tata Mcgraw Hill..
2. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India.
3. Miller, T.J.E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED14	**RENEWABLE POWER GENERATION TECHNOLOGIES**	**4**	**3-0-2**	Basic Electronics and Machines, Power Electronics.

COURSE OUTCOMES (CO):

- To aware of various forms of renewable energy
- To understand in detail the wind energy conversion system and photovoltaic conversion system
- To choose the appropriate renewable energy as an alternate for conventional power in any application
- To design PV systems, wind turbine generator systems and hybrid systems for any application

COURSE CONTENTS:

Sun and Earth-Basic Characteristics of solar radiation-angle of sunrays on solar collector-Photovoltaic cell-characteristics-equivalent circuit-Photovoltaic modules and arrays.

PV Systems-Design of PV systems-Standalone system with DC and AC loads with and without battery storage-Grid connected PV systems-Maximum Power Point Tracking.

Wind energy – energy in the wind – aerodynamics - rotor types – forces developed by blades - Aerodynamic models – braking systems – tower - control and monitoring system -design considerations-power curve - power speed characteristics-choice of electrical generators.

Wind turbine generator systems-fixed speed induction generator-performance analysis-semi variable speed induction generator-variable speed induction generators with full and partial rated power converter topologies - isolated systems-self excited induction generator-permanent magnet alternator -performance analysis.

Hybrid energy systems-wind-diesel system-wind-PV system-micro hydro-PV system-biomass-PV-diesel system-geothermal-tidal and OTEC systems.

SUGGESTED READINGS:

1. Chetan Singh Solanki, “Solar Photovoltaic’s-Fundamentals, Technologies and Applications”, PHI Learning Pvt. Ltd.
2. Van Overstraeton and Mertens R.P, “Physics, Technology and use of Photovoltaics”, Adam Hilger.
3. John F.Walker & Jenkins. N, “Wind energy Technology’, John Wiley and sons.
4. Freries LL, “Wind Energy Conversion Systems”, Prentice Hall.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED15	**POWER SYSTEM OPERATION AND CONTROL**	**4**	**3-0-2**	Optimization Techniques and Advanced Power System Analysis

COURSE OUTCOMES (CO):

- To understand the economics of power system operation with thermal and hydro units
- To realize the requirements and methods of real and reactive power control in power system
- To be familiar with the power system security issues and contingency studies
- Upon completion of this course , students will be able to
- Develop generation dispatching schemes for thermal and hydro units
- Apply control and compensations schemes on a power system
- Adopt contingency analysis and selection methods to improve system security

COURSE CONTENTS:

Economic operation - Load forecasting - Unit commitment – Economic dispatch problem of thermal units – Gradient method- Newton's method – Base point and participation factor method.

Hydro-thermal co-ordination-Hydroelectric plant models – short term hydrothermal scheduling problem - gradient approach – Hydro units in series - pumped storage hydro plants-hydro - scheduling using Dynamic programming and linear programming.

Automatic generation control - Review of LFC and Economic Dispatch control (EDC) using the three modes of control viz. Flat frequency – tie-line control and tie-line bias control – AGC implementation – AGC features - static and dynamic response of controlled two area system.

MVAR control - Application of voltage regulator – synchronous condenser – transformer taps – static VAR compensators.

Power system security - Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs

SUGGESTED READINGS:

i. Robert H. Miller, James H. Malinowski, "Power system operation", Tata McGraw-Hill.
ii. Allen J. Wood, Bruce F. Wollenberg, "Power Generation, Operation and Control", Wiley India Edition.
iii. Abhijit Chakrabarti & SunitaHalder, "Power system Analysis-Operation & Control", PHI.
iv. T J Miller, "Reactive Power Control in Electric Systems",Wiley.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED16	**MICRO CONTROLLER APPLICATIONSIN POWERCONVERTERS**	**4**	**3-0-2**	Knowledge on any digital controller and power electronics may be desirable.

COURSE OUTCOMES (CO):

- Study the internal structure and operation of PIC 16F876 microcontroller and 8051 microcontroller; assembly language program for the generation of firing and control signals employing these microcontrollers.
- Upon completion of this course, students will develop the microcontroller based control schemes for various power electronic circuits.

COURSE CONTENTS:

Use of microcontrollers for pulse generation in power converters - Overview of Zero-Crossing Detectors – typical firing/gate-drive circuits –firing / gate pulses for typical single-phase and three-phase power converters - PIC16F876 Micro-controller – device overview – pin diagrams.

PIC16F876 micro-controller memory organization – Special Function Registers - I/O ports – Timers – Capture/ Compare/ PWM modules (CCP).

Analog to Digital Converter module – Instruction set - instruction description – introduction to PIC microcontroller programming – oscillator selection – reset – interrupts – watch dog timer.

Introduction to MPLAB IDE and PICSTART plus – Device Programming using MPLAB and PICSTART plus – generation of firing / gating pulses for typical power converters.

8051 microcontroller – architecture – addressing modes – I/O ports - instruction sets – simple assembly language programming.

SUGGESTED READINGS:

1. "PIC16F87X Datasheet 28/40 – pin 8 bit CMOS flash Microcontrollers, Microchip technology Inc., 2001. and MPLAB IDE Quick start guide", Microchip technology Inc.
2. John B. Peatman, "Design with PIC Microcontrollers", Prentice Hall.
3. Myke Predko, "Programming and customizing the PIC Microcontroller", Tata McGraw-Hill**.**
4. M.A. Mazidi, J.G. Mazidi and R.D. McKinlay, "The 8051 microcontroller and embedded systems", Prentice Hall India.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED17	SMART GRID TECHNOLOGIES	4	3-0-2	Distribution systems and Measuring instruments.

COURSE OUTCOMES (CO):

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To get familiarized with the power quality management issues in Smart Grid.
- To get familiarized with the high performance computing for Smart Grid applications
- After undergoing the course, the students would get acquainted with the smart technologies, smart meters and power quality issues in smart grids.

COURSE CONTENTS:

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient &Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/ VArcontrol, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

SUGGESTED READINGS:

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
3. Vehbi C. Güngör, DilanSahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards", IEEE Transactions On Industrial Informatics, Vol. 7, No. 4.
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang, "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED18	**ELECTRIC SYSTEMS IN WIND ENERGY**	**4**	**3-0-2**	Electrical machines and power electronics.

COURSE OUTCOMES (CO):

- To introduce the various electrical generators and appropriate power electronic controllers employed in wind energy systems.
- To teach the students the steady-state analysis and operation of different existing configurations of electrical systems in wind energy and also the recent developments taking place in this field.
- Students shall be able to explain the principles of operation of typical electrical systems in wind energy and predetermine their performance.
- They should also able to design and implement the electrical systems and their closed loop control for specific applications.

COURSE CONTENTS:

Principle of operation – steady-state analysis-characteristics of GCIGs- operation of GCIGs with different power electronic configurations.

Process of self-excitation – steady-state equivalent circuit of SEIG and its analysis - performance equations - widening the operating speed-range of SEIGs by changing the stator winding connection with suitable solid state switching schemes - power electronic controllers used in standalone systems.

Need for single-phase operation –typical configurations for the single-phase operation of three-phase GCIGs and SEIGs –stead state equivalent circuit and analysis using symmetrical components.

Different operating modes- steady-state equivalent circuit- performance analysis- DFIG for standalone applications- operation of DFIGs with different power electronic configurations for standalone and grid-connected operation.

Operation of PMSGs- steady-state analysis- performance characteristics- operation of PMSGs with different power electronic configurations for standalone and grid-connected operation.

SUGGESTED READINGS:

1. Marcelo Godoy Simões and Felix A. Farret, “Renewable Energy Systems: Design and Analysis with Induction Generators”, CRC Press, ISBN.
2. Ion Boldea, “Variable speed Generators”, CRCPress.
3. S.N. Bhadra, D.Kastha and S.Banerje, “Wind Electrical Systems’, Oxford University Press.
4. Siegfried Heier, Rachel Waddington, “Grid Integration of Wind Energy Conversion Systems”, Wiley.
5. Freries L L , “Wind Energy Conversion Systems”, Prentice Hall.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED19	**DISTRIBUTED GENERATION AND MICRO-GRIDS**	**4**	**3-0-2**	The students are preferred to have a basic knowledge in Power System Analysis and Distribution Systems

COURSE OUTCOMES (CO):

- To understand the planning and operational issues related to Distributed Generation and Micro-grids.
- On completion of the course, the students will be able to design a micro-grid taking into consideration the planning and operational issues of the Distributed Generators to be connected in the system.

COURSE CONTENTS:

Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, and Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.

Grid integration of DGs – Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units. Energy storage elements: Batteries, ultra-capacitors, flywheels.

Technical impacts of DGs – Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.

Economic and control aspects of DGs –Market facts, issues and challenges - Limitations of DGs. Voltage control techniques, Reactive power control, Harmonics, Power quality issues. Reliability of DG based systems – Steady-state and Dynamic analysis

Introduction to micro-grids – Types of micro-grids – autonomous and non-autonomous grids – Sizing of micro-grids- modeling & analysis- Micro-grids with multiple DGs – Micro-grids with power electronic interfacing units. Transients in micro-grids - Protection of micro-grids – Case studies.

SUGGESTED READINGS:

1. H. Lee Willis, Walter G. Scott,"Distributed Power Generation – Planning and Evaluation", Marcel Decker Press.
2. M.GodoySimoes, Felix A.Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC press.
3. Robert Lasseter, Paolo Piagi, "Micro-grid: A Conceptual Solution", Power Electronics Specialists Conference.
4. F. Katiraei, M.R. Iravani, "Transients of a Micro-Grid System with Multiple Distributed Energy Resources", International Conference on Power Systems Transients.
5. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson "Facility Microgrids", Subcontract report, General Electric Global Research Center.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED21	**POWER SYSTEM PLANNING AND RELIABILITY**	**4**	**3-0-2**	Power system analysis, Power system transmission and distribution, Matrices, Probability and Calculus.

COURSE OUTCOMES (CO):

- To acquire skills in planning and building reliable power system.
- The scope of employability in power utilities will increase.
- The management skills required in the field of power system engineering is enhanced.

COURSE CONTENTS:

OUTCOMESS 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.

Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique. Generator system reliability analysis – probability models for generators unit and loads – reliability analysis of isolated and interconnected system – generator system cost analysis – corporate model – energy transfer and off peak loading.

Transmission system reliability model analysis – average interruption rate - LOLP method - frequencyand duration method.

Two plant single load system - two plant two load system-load forecasting uncertainly interconnections benefits.

Introduction to system modes of failure – the loss of load approach – frequency & duration approach – spare value assessment – multiple bridge equivalents

SUGGESTED READINGS:

1. Sullivan, R.L., "Power System Planning", Heber Hill.
2. Roy Billington, "Power System Reliability Evaluation", Gordan & Breach Scain Publishers.
3. Eodrenyi, J., 'Reliability modeling in Electric Power System' John Wiley.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED22	CONTROL DESIGN TECHNIQUES FOR POWER ELECTRONIC SYSTEMS	4	3-0-2	Classical Control, Systems Theory, Power Converters

COURSE OUTCOMES (CO):

- The main objective of this course is to study the application of modern control theory to power electronic converters and drives.
- The main OUTCOMES from this course is the modern controller design techniques for power converters.

COURSE CONTENTS:

Review of basic control theory – control design techniques such as P, PI,PID and lead lag compensator design. Review of state space control design approach – state feedback controller and observer design.

Control of DC-DC converters. State space modeling of Buck, Buck-Boost, Cuk, Sepic, Zeta Converters. Equilibrium analysis and closed loop voltage regulations using state feedback controllers and sliding mode controllers.

Control of rectifiers. State space modeling of single phase and three phase rectifiers. State feedback controllers and observer design for output voltage regulation for nonlinear loads. Analysis of continuous and discontinuous mode of operation.

Modeling of Brushless DC motors and its speed regulations – State space model, sensor less speed control of BLDC motor and Sliding mode control design for BLDC motor. Modeling and control of switched reluctance motor.

Modeling of multi input DC-DC converters and its application to renewable energy. Output voltage regulation of Multi input DC-DC converter using state feedback controllers.

SUGGESTED READINGS:

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching Power Converters”, CRC Press.
3. Bimal Bose, “Power electronics and motor drives”, Elsevier.
4. Ion Boldea and S.A Nasar, ‘Electric drives’, Chemical rubber company press.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED23	**ELECTRIC AND HYBRID VEHICLES**	**4**	**3-0-2**	Power Conversion Techniques, Electrical Machines

COURSE OUTCOMES (CO):

- This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
- The main OUTCOMES from this course is deeper understanding of various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc

COURSE CONTENTS:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. 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. Basic concepts of electric traction, introduction to various electric drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

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

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

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

SUGGESTED READINGS:

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching Power Converters”, Chemical Rubber Company Press.
3. Bimal Bose, “Power electronics and motor drives”, Elsevier.
4. Ion Boldea and S.A Nasar, “Electric drives”, Chemical Rubber Company Press.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED24	ENERGY STORAGE SYSTEMS	4	3-0-2	Fundamental Chemistry and Material Science

COURSE OUTCOMES (CO):

- To emphasize basic physics, chemistry, and engineering issues of energy storage devices, such as batteries, thermoelectric convertors, fuel cells, super-capacitors.
- Upon completion of this course , students will be able to apply energy storage schemes in electrical systems

COURSE CONTENTS:

Prospect for both traditional and renewable energy sources - detailed analysis of Indian energy market and future need through 2020 - energy, economic growth and the environment, implications of the Kyoto Protocol, and structural change in the electricity supply industry

Batteries - performance, charging and discharging, storage density, energy density, and safety issues, classical batteries - Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide, and modern batteries -Zinc-Air, Nickel Hydride, Lithium Battery.

Thermoelectric - electron conductor and phonon glass, classical thermoelectric materials (i) four-probe resistivity measurement, Seeback coefficient measurement, and thermal conductivity measurement.

Supercapacitors - types of electrodes and some electrolytes, Electrode materials - high surface area activated carbons, metal oxide, and conducting polymers, Electrolyte - aqueous or organic, disadvantages and advantages of supercapacitors - compared to battery systems, applications - transport vehicles, private vehicles, and consumer electronics – energy density, power density, price, and market.

Fuel cells - direct energy conversion - maximum intrinsic efficiency of an electrochemical converter, physical interpretation - Carnot efficiency factor in electrochemical energy convertors, types of fuel cells - hydrogen oxygen cells, hydrogen air cell, alkaline fuel cell, and phosphoric fuel cell.

SUGGESTED READINGS:

1. Tetsuya Osaka, Madhav Datta, “Energy Storage Systems in Electronics”, Gordon and Breach Science Publishers.
2. R. M. Dell, D.A.J. Rand, “Understanding Batteries”, RSC Publications.
3. James Larminie, Andrew Dick, “Fuel Cell System Explained”, John’s Wiley.

D.M. Rowe, “Thermoelectrics Handbook: Macro to Nano”, CRC Press.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED25	**EMBEDDED PROCESSORS AND CONTROLLERS**	**4**	**3-0-2**	Digital Electronics, Microcontroller and microprocessor, Computer Architecture.

COURSE OUTCOMES (CO):

- To enrich the leaner with process and controller design concepts with special concentration on system-on-chip and system-on-programmable-chip.
- The student will excel in the system design and testing with embedded processors and controllers suited for varied applications.

COURSE CONTENTS:

MSP 430 Microcontroller – Functional block diagram – memory – Interrupts and Resets – Input/ Output units – Instruction set – Addressing modes – Constant generator and Emulated Instructions.

MSP 430 Timers – on-chip data conversion systems – ADC and DAC – on-chip communication peripherals – SPI, I^2C, UART – Programming concepts.

ARM7TDMI – architecture overview - processor modes – data types – Registers – program status registers – Simple programs.

Introduction to Design of Systems on a chip – Core architectures for Digital media and compilation techniques – Microsystems technology and applications – Hardware/ software co-design concepts.

Multi-core System-on-Chip (McSoC) design – Application specific McSoC design – Queue Core Architecture – Synthesis and evaluation results – Reconfigurable multi-core architectures.

Instruction set assembly directives, liner assembly - ASM statement within C – timers – interrupts - multi channel buffering serial ports - direct memory access - memory consideration - fixed and floating points format - code improvement and constraints - Fast Fourier Transform

SUGGESTED READINGS:

1. H. Davies, “MSP 430 Microcontroller Basics”, Elsevier Ltd.
2. William Hohl, “ARM Assembly Language, Fundamentals and Techniques”, CRC Press.
3. Abderazek Ben Abdallah, “Multi-core systems on-Chip: Practical software and Hardware design”, Atlantis press.
4. Ricardo Reis, Marcelo Lubaszewski, Jochen A.G. Jess, “Design of Systems on a chip: Design andTes”, Springer.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED26	**COMPUTER RELAYING AND WIDE AREA MEASUREMENT SYSTEMS**	**4**	**3-0-2**	Digital Signal Processing, Power system protection, Power system analysis

COURSE OUTCOMES (CO):

- To understand the operating principles of a computer relays and wide area measurement systems.
- Learning about main classification of relay types, wide area measurement systems and their behavior, mathematical background for understanding relaying algorithms .
- Examining line relaying algorithms and protection of power system components of a computer relay and analog to digital converters as and system relaying and control.
- Upon finishing the course, students are expected to accomplish the following OUTCOMESS: Demonstrate knowledge of fundamental aspects of the theories, principles and practice of computer relaying; Define and understand the concept of Wide area measurement systems; understand and design wide are measurement systems application in Smart grid

COURSE CONTENTS:

Historical background - Expected benefits – computer relay architecture - Analog to digital converters - Anti-aliasing filters - Substation computer hierarchy - Fourier series Exponential fourier series - Sine and cosine fourier series – Phasor.

Walsh functions - Fourier transforms - discrete fourier transform - Random processes - Filtering of random processes - Kalman filtering - Digital filters - Windows and windowing, - Linear phase Approximation - filter synthesis – Wavelets – Elements of artificial intelligence.

Introduction - Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors – Non recursive updates – Recursive updates – Frequency Estimation.

A generic PMU - The global positioning system - Hierarchy for phasor measurement systems, - Functional requirements of PMUs and PDCs - Transient Response of Phasor Measurement Units-of instrument transformers, filters, during electromagnetic transients - Transient response during power swings.

State Estimation - History, Operator's load flow - weighted least square least square, -Linear weighted least squares - Nonlinear weighted least squares - Static state estimation - State estimation with Phasors measurements - linear state estimation - Adaptive protection - Differential and distance protection of transmission lines – Adaptive protection – Adaptive out-of-step protection

SUGGESTED READINGS:

1. A.G. Phadke, J.S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons Ltd., Research Studies Press Limited.
2. A.G. Phadke, J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer Publications.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED27	**TRANSIENT OVER VOLTAGES IN POWER SYSTEMS**	**4**	**3-0-2**	Advanced Power System Analysis

COURSE OUTCOMES (CO):

- To make the students familiar with the theoretical basis for various forms of over voltages such as lighting strokes, surges, switching transients etc., and to introduce some of the protection measures against such over voltages are described. Also to depict the necessity and methods for generating impulse voltages and currents.
- The students will be able to understand the basis for mathematical modeling of various over voltages, and analyze different situations. They will be aware of the preliminary design aspects of protection equipment needed and impulse voltage and current generators.

COURSE CONTENTS:

Transients in electric power systems – Internal and external causes of over voltages –– Lightning strokes – Mathematical model to represent lightning, Travelling waves in transmission lines – Circuits with distributed constants – Wave equations – Reflection and refraction of travelling waves – Travelling waves at different line terminations

Switching transients – double frequency transients – abnormal switching transients – Transients in switching a three phase reactor - three phase capacitor

voltage distribution in transformer winding – voltage surges-transformers – generators and motors - Transient parameter values for transformers, reactors, generators and transmission lines

Basic ideas about protection – surge diverters-surge absorbers - protection of lines and stations Modern lighting arrestors - Insulation coordination - Protection of alternators and industrial drive systems

Generation of high AC and DC-impulse voltages, currents - measurement using sphere gaps-peak voltmeters - potential dividers and CRO

SUGGESTED READINGS:

1. Allen Greenwood, “Electrical transients in power systems”,Wiley Interscience.
2. Bewley, L.V., “Travelling waves on Transmission systems”, Dover publications, New York.
3. Gallaghar, P.J. and Pearman, A.J., “High voltage measurement, Testing and Design”, John Wiley and sons, New York.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED28	**DIGITAL SIMULATIONOF POWER ELECTRONIC SYSTEMS**	**4**	**3-0-2**	Knowledge in Power Electronics and machines.

COURSE OUTCOMES (CO):

- To provide knowledge on modeling and simulation of power simulation circuits and systems.
- The candidate will be able to simulate power electronic systems and analyze the system response.

COURSE CONTENTS:

Review of numerical methods. Application of numerical methods to solve transients in D.C Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.

Modeling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modeling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

State space modeling and simulation of linear systems. Introduction to electrical machine modeling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self commutated devices- simulation of power factor correction schemes, Simulation of converter fed dc motor drives ,Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed dc motor.

Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation, pulse-width modulation methods for voltage control, waveform control. Simulation of inverter fed induction motor drives.

SUGGESTED READINGS:

1. Simulink Reference Manual, Math works, USA.
2. Robert Ericson, “Fundamentals of Power Electronics”, Chapman & Hall.
3. Issa Batarseh, “Power Electronic Circuits”, John Wiley & sons.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED30	**FAULT DETECTION AND DIAGNOSIS**	**4**	**3-0-2**	Basic knowledge of Control Systems, Process control

COURSE OUTCOMES (CO):

- To learn basic principle of Faulty detection and diagnosis.
- Upon completion of this course, the students can able to
- Know about different type of faults occurred in a system.
- Understand Mathematical analysis of different faults.
- Understand Structured and directional concepts techniques for FDI design.

COURSE CONTENTS:

Introduction to Fault Detection and Diagnosis: Scope of FDD:- Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications. Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation. Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation. Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column. Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

SUGGESTED READINGS:

1. Janos J. Gertler, "Fault *Detection and Diagnosis in Engineering systems"*, Macel Dekker.
2. Sachin. C. Patwardhan,"*Fault Detection and Diagnosis in Industrial Process"* – Lecture Notes, IIT Bombay.
3. Rami S. Mangoubi, "*Robust Estimation and Failure detection"*. Springer-Verlag-London .

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED31	**Intelligent Control**	**4**	**3-0-2**	Control systems-I, Control systems-II

COURSE OUTCOMES (CO):

- To understand Intelligent systems.
- To understand different types of single layer and multilayer Neural networks.
- To understand fuzzy logic.
- To have exposure of Fuzzy controller and its applications in control systems

COURSE CONTENTS:

UNIT 1. 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. Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods, Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA

UNIT 2. System Identification using Fuzzy and Neural Network

UNIT 3. Fuzzy logic and Neural Network Controller design for Direct and Indirect Adaptive Control

UNIT 4. Applications of above mentioned techniques to Non-Linear Dynamical Systems.

SUGGESTED READINGS:

1. J M Zurada ,"An Introduction to ANN", Jaico **Publishing** House
2. Simon Haykins ,"Neural Networks", Prentice Hall
3. Timothy Ross ,"Fuzzy Logic with Engg.Applications", McGraw. Hill
4. Driankov, Dimitra ,"An Introduction to Fuzzy Control", Narosa Publication
5. Golding ,"Genetic Algorithms", Addison-Wesley **Publishing** Com

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED32	**REACTIVE POWER CONTROL & FACTS DEVICES**	**4**	**3-0-2**	Power Electronics

COURSE OUTCOMES (CO):

- Describe how FACTS and HVDC are designed,
- Explain and analyze their functions,
- Derive basic mathematical models for these components,
- Analyze the impact of these components on power system stability,
- Perform calculations on different control strategies for these devices.

COURSE CONTENTS:

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

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

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

Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters- power circuit configurations.

UPFC -Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

SUGGESTED READINGS:

1. Song, Y.H. and Allan T. Johns, "Flexible ac transmission systems (FACTS)", Institution of Electrical Engine Press.
2. Hingorani ,L.Gyugyi ,"Concepts and Technology of flexible ac transmission system", IEEE Press New York.
3. IEEE Tutorials on '"Flexible ac transmission systems", published in Power Engineering Journal.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED33	Soft Computing	4	3-0-2	Control System I

COURSE OUTCOMES (CO):

- Knowledge of Nero systems, Architecture learning rules etc
- Knowledge of Fuzzy logic and ANFIS

COURSE CONTENTS:

UNIT1. Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptron, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Applications of Artificial Neural Networks.

UNIT 2.Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersection, Union, Combination of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers.

UNIT 3. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges. Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, and Fuzziness of Fuzzy Sets. Applications of Fuzzy.

UNIT 4. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks. Application of Fuzzy Logic: Medicine, Economics etc. Genetic Algorithm: An Overview, GA in problem solving.

SUGGESTED READINGS:

1. S. Haykin, “Neural Networks: A comprehensive Foundation”, , Prentice Hall Inc..
2. Klir G.J and Folger T.A, “Fuzzy sets, Uncertainty and Information”, Prentice Hall.
3. Negoita, “Expert Systems and Fuzzy Systems”, Benjamin Cummings.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED34	ENERGY AUDITING	4	3-0-2	Power Apparatus and Power Systems

COURSE OUTCOMES (CO):

Upon completion of this course the student shall be able to:

- To impart knowledge on energy auditing and its applications.
- Financial management and its application in renewable system.

COURSE CONTENTS:

Energy Scenario

Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.

Energy Management and Audit

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Material and Energy Balance

Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.

Financial Management

Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

Electrical System

Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution a transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding a motor replacement issues, energy efficient motors. Light source, Choice of lighting, Luminance requirements, a Energy conservation avenues

SUGGESTED READINGS:

1) Abbi, Y.P. and Jain, S ,"Handbook on Energy Audit and Environment Management", Teri Press.
2) P.Diwan and P.Dwivedi ,"Energy Conservation", Pentagon Press.
3) A.Thumann, W.J.Younger, T.Niehus, "Handbook of Energy Audits", CRC Press.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED35	VIRTUAL INSTRUMENT DESIGN	4	3-0-2	Instrumentation

COURSE OUTCOMES (CO):

- Explain virtual instrument concepts.
- Select proper data acquisition hardware.
- Configure data acquisition hardware in LabVIEW.
- Use LabVIEWand configure the related hardware like DAQ and transducers.
- Create virtual instruments for practical works.

COURSE CONTENTS:

Virtual Instrumentation: Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

VI programming techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/ Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Fire wire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation**:** Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

SUGGESTED READINGS:

1. Gary Johnson, “LabVIEW Graphical Programming”, McGraw Hill.
2. Lisa K. wells & Jeffrey Travis, “LabVIEW for everyone”, Prentice Hall.
3. Jane W. S. Liu, “Real-time Systems”, Pearson Education India.
4. Jean J. Labrosse, “Embedded Systems Building Blocks: Complete and Ready-to-use Modules in C”, CMP Books.
5. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes,.
6. Jean J. Labrosse, “MicroC/OS-II.The Real-time Kernal”, CMP Books.
7. www.ni.com
8. www.ltrpub.com

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED36	**Non Linear System Control using Neural and Fuzzy Reinforcement Learning**	**4**	**3-0-2**	N.A

COURSE OUTCOMES (CO):

- Solve problems using classical methods for analysis of nonlinear dynamical systems, such as linearization and phase-plane analysis, equilibria and oscillations.
- Use Simulink for modeling and simulation of nonlinear systems.
- In depth knowledge on how to solve stability problems using Lyapunov and LaSalle methods.
- In depth knowledge about input-output stability using the circle criterion and describing function analysis.
- The students should be able to apply this theory to compensation for saturation (anti-windup), friction, back-lash and quantization.
- Basic knowledge about passivity theory.
- Be able to solve simpler control design problems using high-gain design methods, such as linearization by high gain and sliding modes.
- Be able to solve simpler control design problems using Lyapunov design methods and feedback linearization.
- Determine controllability for nonlinear systems.
- Have basic knowledge about optimal control theory, and how to solve standard optimal control problems.

COURSE CONTENTS:

Introduction: Reinforcement Learning, Elements of Reinforcement Learning, History of Reinforcement Learning
The Reinforcement Learning Problem: The Agent-Environment Interface, Goals and Rewards, Returns, Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation
Elementary Solution Methods: Dynamic Programming, Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming
Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control, Actor-Critic Methods
Eligibility Traces: One Step TD Prediction, The Forward View of TD, The Backward View of TD, Equivalence of Forward and Backward Views, Sarsa, Q, Eligibility traces
Generalization and Function Approximation: Value Prediction with Function Approximation, Neural network based RL, Fuzzy Q Learning
Game theory based RL: Noise or disturbance as opponent, Markov games, Game theory, Neural Markov game control, Fuzzy RL based controllers
Control Problems: Inverted Pendulum, Standard Two link Robotic Manipulator, Mobile Robot, SCARA robotic manipulator and other control problems

SUGGESTED READINGSS:

1. Richard S. Sutton and Andrew G Barto,"Reinforcement Learning: An Introduction"by.
, The MIT Press, Cambridge, Massachusetts London, England
2. Jennie Si, A. G. Barto, W. B. Powell, and D. Wunsch ,"Handbook of Learning and Approximate Dynamic Programming". Willey-IEEE Press.

-

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
IED37	DESIGN TECHNIQUES FOR SMPS	4	3-0-2	Power Electronics course magnetic, Basics of EMC & any power simulation environment.

COURSE OUTCOMESS (CO):

- To give a practical step by step approach for design and assembly of Power Supplies and apply the necessary recent technology to comply the standards and certification requirements.
- An ability to design a system or component, or process to meet the stated practical specifications and standards.
- An ability to use modern engineering techniques, skills, and tools to implement and organize system design and engineering under stated conditions

COURSE CONTENTS:

Introduction of Available Sources & demanding loads: Sources - AC mains, Lab supplies, Batteries, Solar Cells Loads - Requirements of load, battery as load, Selection of Topology : Step-Up / Step-Down, Multiple outputs, Continuous & discontinuous modes of operation, Isolated converters, Various configurations of Converters, Selection of Components: Selection of Resistors, Chokes, Capacitors, Diodes, MoSFETs& IGBTs, Connectors, Design of Magnetics Fundamentals & ideal conditions, design of High frequency chokes& transformers, Selection of wire gauge, sealing of magnetics.

Guide to Instrumentation: Basics of measurements using DMM, Oscilloscope, Electronic loads, etc Design of Magnetics Fundamentals & ideal conditions, design of High frequency chokes & transformers, Selection of wire gauge, sealing of magnetics Design of Feedback circuits Basic control requirements, Current & voltage mode control fundamentals & system stability conditions Design of Control and Monitoring circuits Practical Control circuitry& Monitoring circuitry requirements

Evaluations and Thermal management Performance evaluations of SMPS & thermal loss calculations and cooling options & packaging of converter EMI control requirements Overview of EMC, differentiating signal and noise, Layout concepts Low & High frequency filtering requirements, Optimal filter design Worst case analysis Introduction to datasheet READINGS, operation tuned to datasheet, typical worst case analysis.

Standards governing the power supplies IEC standards for Electrical & Environmental testing, certification standards, Ingress protection standards Recent trend in Power supplies Recent advancements in components, Recent advancements in topologies, Digital control of power supplies, Power Integration & its Low power applications.

Analysis and Simulation using PSIM: BUCK, BOOST & BUCK BOOST, Typical discrete power factor corrector circuit.

SUGGESTED READINGSS:

1. Ned Mohan , Undeland and Robbins, “Power Electronics Converters, Applications and Design”, John Wiley & sons.
2. Abraham I Pressman, Keith Billings, Taylor Morey, “Switching Power Supply Design”, McGraw-Hill.
3. L. Umanand and S R Bhat, ”Design of Magnetic Components for Switched Mode Power Converters” ,Wiley Eastern Limited.

Syllabus of Open Electives

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO001	Technical Communication	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):

1. The course will improve writing and documentation skills of students with emphasis on the importance of effective communication with focus on choice of words, formation of proper sentence structures and writing styles.
2. This will enhance the students capability to prepare technical documents and correspondence.
3. The course will equip the student with good communications skills for placements, preparing SOPs and CVs.
4. The course will sensitize the students towards research ethics, copyright and plagiarism.

COURSE CONTENT:

- Definition of communication, meaning, importance & process of communication, OUTCOMESS, types, C's of communication, barriers to communication
- human & non -human communication, distinctive features of human languages
- Business correspondence-definition, meaning and importance of business communication, business letters-purchase, enquiry, quotation, order, follow up, acceptance-refusal
- Emphasis on (i) paragraph writing, its kinds, coherence & cohesion
  (ii)writing a paragraph/thesis: selection of topic and its development
  (iii) writing reports, manuals, notices, memos, agendas, minutes
  (iv)Interviews, speeches, presentations,
- Research ethics, methodologies, copyright, plagiarism

SUGGESTED READINGSS:

- Martin Hewing ,"Advanced English Grammar" Cambridge University Press,
- Meenakshi Raman & Sangeeta Sharma ,"Technical Communication" ", Oxford University Press India.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO002	Disaster Management	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):-

1. Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

COURSE CONTENT:

Unit -I: Introduction

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

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.

Unit -II: 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

Unit -III: 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.

Unit -IV: 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.

Unit -V: Disaster Mitigation

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

SUGGESTED READINGSS:

1. R. Nishith, Singh AK," Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. ," Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO003	Basics of Financial Management	3L-1T-0P	4	None

COURSE OBJECTIVE(CO):-

- The course's objective is to provide a theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice. In this course, you will enhance your knowledge and understanding of financial management. You will learn how managers should organize their financial transactions effectively and with integrity and how to give everybody the ability and confidence to tackle common financial problems in practice. It will also provide adequate preparation for future finance classes.

COURSE CONTENT:

Unit I

Nature, scope and OUTCOMESS of financial management, Time value of money, Risk and return (including Capital Asset Pricing Model).

Unit II

Long term investment decisions: The Capital Budgeting Process, Cash Flow Estimation, Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Net Terminal Value, Internal Rate of Return (IRR), Profitability Index.

Unit III

Financing Decisions: Sources of long-term financing, Estimation of components of cost of capital, Methods for calculating Cost of Equity, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average Cost of Capital (WACC). Capital Structure- Theories of Capital Structure (Net Income, Net Operating Income, MM Hypothesis, Traditional Approach). Operating and Financial leverage. Determinants of capital structure

Unit IV

Dividend Decisions: Theories for Relevance and irrelevance of dividend decision for corporate valuation-Walter's Model, Gordon's Model, MM Approach, Cash and stock dividends. Dividend policies in practice.

Unit V

Working Capital Decisions: Concepts of Working Capital, Operating & Cash Cycles, sources of short term finance, working capital estimation, cash management, receivables management, inventory management.

SUGGESTED READINGSS:

1. Khan, M.Y. and P.K. Jain," Financial Management: Text and Problems", Tata McGraw Hill.
2. Srivastava, Rajiv, and Anil Mishra," Financial Management", Oxford University Press, UK.
3. Chandra, P. ,"Financial Management-Theory and Practice", Tata McGraw Hill.
4. Horne, Van; James C., John Wachowicz," Fundamentals of Financial Management", Pearson Education.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO004	**Basics of Human Resource Management**	**3L-1T-0P**	**4**	**None**

COURSE OBJECTIVE(CO):-

- This course is designed to provide students with an understanding of human resource management (HRM) functions within organizations, including an appreciation of the roles of both HRM specialists and line managers in designing and implementing effective HRM policies and practices.

COURSE CONTENT:

Unit - I

Evolution and growth of human resource management (with special reference to scientific management and Human relations approaches).Role of HR in strategic management .Nature. OUTCOMESS, scope, and functions of HR management.

Unit - II

Challenges of HR (the changing profile of the workforce - knowledge workers, employment opportunities in BPOs, IT and service industries, Flexi options), Workforce diversity (causes, paradox, resolution of diversity by management).

Unit III

HRD; Human resource management as a profession. Concepts of line-staff in the structure of human resource department and the role of human resource manager.

Unit - IV

Manpower planning -OUTCOMESS, elements, advantages, process. Job design - (simplification, rotation, enlargement, enrichment and approaches}.Job analysis .Job evaluation.

Unit - V

Recruitment (factors affecting, sources, policy, evaluation). Selection (procedure, tests, interviews). Placement and Induction.

SUGGESTED READINGSS:

1. Aswathappa K. ," Human Resource and Personnel Management", Tata McGraw-Hill, New Delhi.
2. Chhabra T.N. ," Human Resource Management", Dhanpat Rai and Co. Delhi.
3. Saiyadain S. Mirza ,"Human Resource Management", Tata Mc-Graw Hill, India.
4.Chadha, N.K.," Human Resource Management-issues, case studies, experiential exercises", Sri Sai Printographers, New Delhi.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO005	**Project Management**	**3L-1T-0P**	**4**	**None**

COURSE OUTCOMESS:-

- In this comprehensive course, student will learn the fundamentals of project management: how to initiate, plan, and execute a project that meets OUTCOMESS and satisfies stakeholders. This course provides a step-by-step guide to planning and executing a project and to develop a manageable project schedule.

COURSE CONTENT:

Unit-I

OUTCOMESS of Project Planning, monitoring and control of investment projects. Relevance of social cost benefit analysis, identification of investment opportunities. Pre-feasibility studies.

Unit-II

Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements; financial planning; Estimation of fund requirements, sources of funds .Loan syndication for the projects .Tax considerations in project preparation and the legal aspects.

Unit-III

Project appraisal: Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques. Estimation of shadow prices and social discount rate.

Unit-IV

Project review/control-Evaluation of project. PERT/CPM .resource handling/leveling.

Unit-V

Cost and Time Management issues in Project planning and management, success criteria and success factors, risk management.

SUGGESTED READINGSS:

1. Ravi Ravindran, " Operations Research and Management Science Handbook", CRC Press.
2. Harold Kerzner," Applied Project Management: Best Practices on Implementation", John Wiley & Sons, Inc..
3. Goodpasture, J. C.," Quantitative Methods in Project Management", J Ross Publishing, Boca Raton..
4. Meredith, J. R. and Mantel Jr., S. J.," Project Management: A Managerial Approach", John Wiley.
5. Richard D. Irwin ,Clifford Gray," Project Management", Mcgraw-Hill

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO006	Basics of Corporate Law	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):

- The objective of this Course is to provide in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization; analyze and interpret management information; make decisions based on the information available; communicate information effectively; understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information; explain and appraise the taxation laws which govern corporations and individuals.

COURSE CONTENT:

Unit I: Introduction : Administration of Company Law, characteristics of a company; common seal; lifting of corporate veil; types of companies including private and public company, government company, foreign company, one person company, small company, associate company, dormant company, producer company; association not for profit; illegal association; formation of company, promoters and their legal position, pre incorporation contract and provisional contracts; on-line registration of a company.

Unit II: Documents: Memorandum of association and its alteration, articles of association and its alteration, doctrine of constructive notice and indoor management, prospectus, shelf prospectus and red herring prospectus, misstatement in a prospectus; GDR; book building; issue, allotment and forfeiture of shares, calls on shares; public offer and private placement; issue of sweat capital; employee stock options; issue of bonus shares; transmission of shares, buyback and provisions regarding buyback; share certificate; D-Mat system; membership of a company.

Unit III: Management and Meetings: Classification of directors, additional, alternate and adhoc director; women directors, independent director, small shareholders' director; director identity number (DIN); appointment, who can appoint a director, disqualifications, removal of directors; legal position, powers and duties; key managerial personnel, managing director, manager; meetings of shareholders and board; types of meeting, convening and conduct of meetings, requisites of a valid meeting; postal ballot, meeting through video conferencing, e-voting; committees of board of directors – audit committee, nomination and remuneration committee, stakeholders relationship committee, corporate social responsibility committee; prohibition of insider trading.

SUGGESTED READINGSS:

1. Hicks, Andrew & Goo S.H., "Cases and Material on Company Law", Oxford University Press
2. Gowar, LCB, "Principles of Modern Company Law", Stevens & Sons, London.
3. Majumdar, A.K., and G.K. Kapoor, "Company Law and Practice", Taxmann, New Delhi
4. Hanningan, Brenda," Company Law", Oxford University Press, U.K.
5. Sharma, J.P.," An Easy Approach to Corporate Laws", Ane Books Pvt. Ltd., New Delhi
9. Ramaiya, "A Guide to Companies Act", Lexis Nexis Butters worth wadhwa
6. Kannal, S., & V.S. Sowrirajan, "Company Law Procedure", Taxman's Allied Services (P) Ltd., New Delhi.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO007	BIOLOGICAL COMPUTING	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):

1. To understand computing in context of biological systems.
2. To understand computing languages needed to solve biological problems.
3. To acquire computational skills for analysis of biological processes through grid computing.
4. To gain knowledge of different biological databases and their usage.
5. To gain innovative insight into DNA computing.

COURSE CONTENT:

Introduction, Orientation and UNIX,
Python: Introduction to Variables and Control flow, Python II - Parsing In and Output, Python III - Scripting and Functions, Python IV- Number Crunching and Plotting,
Grid computing, Biogrid, R basics and Visualization, Unix for fast text processing, SQL Database
Biological databases, R for speed, R for fun, Local BLAST, Unit Testing and Code Correctness
DNA computing,

SUGGESTED READINGSS:

1. H. Bolouri, R. Paton ,"Computations in cells & tissues", Springer.
2. Haubold**,** Bernhard**,** Wiehe, Thomas,"Introduction to Computational Biology: An Evolutionary Approach.",Springer

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO008	Basics of Social Sciences	3L-1T-0P	4	None

COURSE OUTCOMESS

- **Social science** is a major category of academic disciplines, concerned with society and the relationships among individuals within a society. It in turn has many branches, each of which is considered a "social science".

COURSE CONTENT:

Unit I: Economics, political science, human geography, demography and sociology.
Unit II: Humanities, anthropology, archaeology, jurisprudence, psychology, history, and linguistic.
Unit III: Political science, economics, sociology, international politics and scientific methodology.

Books:

- Chaturvedy, J. C., " Political Governance: Political theory" , Isha Books
- Jordan-Bychkov, Terry G.; Domosh, Mona; Rowntree, Lester, "The human mosaic: a thematic introduction to cultural geography" , Harper Collins College Publishers
- Ashley D, Orenstein DM, " Sociological theory: Classical statements ", Pearson Education.
- Wallerstein, I., "Anthropology, Sociology, and Other Dubious Disciplines", Current Anthropology.
- Kuhn, Thomas S. , " The Structure of Scientific Revolutions", University of Chicago Press
- Joseph Raz, "The Authority of Law ", Oxford University Press

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO009	ENTREPRENEURSHIP	3L-1T-0P	4	None

COURSE OUTCOMESS

- This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.

COURSE CONTENT:

Unit I-Introduction:

Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

Unit II- Creating Entrepreneurial Venture:

Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Challenges in managing innovation; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership- components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection- Patents Trademarks and Copyrights – importance for startups, Legal Acts Governing Business in India.

Unit III-Functional plans:

Marketing plan– for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, pro forma cash budget, funds Flow and Cash flow statements; Pro forma balance sheet; Break Even Analysis; Ratio Analysis.

Unit IV- Entrepreneurial Finance:

Debt or equity financing, Sources of Finance- Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

Unit V- Enterprise Management:

Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers & acquisitions.

SUGGESTED READINGSS:

1. Kumar, Arya, “Entrepreneurship: Creating and Leading an Entrepreneurial Organization”, Pearson, India.
2. Hishrich., Peters, “Entrepreneurship: Starting, Developing and Managing a New Enterprise”,Irwin.
3. Taneja, “Entrepreneurship”, Galgotia Publishers.
4. Barringer, Brace R., and R. Duane Ireland,” Entrepreneurship”, Pearson Prentice Hall, New Jersy (USA) .
5. Hisrich, Robert D., Michael Peters and Dean Shephered, “Entrepreneurship”, Tata McGraw Hill, New Delhi.
6. Lall, Madhurima, and Shikha Sahai,” Entrepreneurship”, Excel Books, New Delhi
7. Charantimath, Poornima, “Entrepreneurship Development and Small Business Enterprises”, Pearson Education, New Delhi.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO010	Social work	3L-1T-0P	4	None

COURSE OBJECTIVE(CO):

- **In this course students will learn about various methods of social work, about community organization, social welfare administration, Problems pertaining to Marriage, Family and caste.**

COURSE CONTENT:

Unit 1. Social work

Philosophy and Methods. Social work: Meaning, OUTCOMESS, Scope, Assumptions & Values; History of Social work in U.K. U.S.A. and India, philosophy of Social Work. Democratic (Equality, Justice Liberty & Fraternity) and Humanitarian (Human Rights) Matrix .Social works as a profession.

Unit 2. Methods of Social work

Meaning, Scope Principles, Processes (Psychosocial study, Assessments, treatment-goal formulation and techniques), Evaluation, Follow-up and Rehabilitation. Social Groups work: Meaning, Objective, Principles, Skills, Processes (Study, Diagnosis, treatment and evaluation), Programme , Planning and Development, Role of Social group worker, Leadership Development.

Unit 3 Community organization

Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.

Unit 4 Social Welfare Administration

Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning .organization, budgeting and financial control, reporting. Social work Research: Meaning OUTCOMESS, types, scope, scientific method, Selection and formulation of the problem Research Design Sampling, Sources and Methods of Data Collection, Processing of Data, analyzing and interpretation, Report writing. Social Action: Meaning, Scope, approaches (Sarvodays, Antyodaya etc.) and Strategies.

Unit 5 Work in India Problem pertaining to Marriage, Family and caste

Dowry- child Marriage, Divorce, Families with working couples, Disorganized Families, Families with Emigrant Heads of the Households, Gender Inequality, Authoritarian Family structure, Major Changes in Caste systems and problem of casteism. Problems Pertaining of Weaker Sections. Problems of Children, Women Aged. Handicapped and Backward Classes (SCs, STs, and other Backward Classes). **Problems of Deviance:** Truancy Vagrancy and Juvenile Delinquency, Crime, White Colla Crime, Organized Crime ,Collective Violence, Terrorism, Prostitution and Sex Related Crimes. Social Vices: Alcoholisms. Drug Addiction, Beggary, Corruption and communalism. **Problems of Social Structure :** Poverty, Unemployment, Bonded Labour, Child Labour. **Fields of Social work India :** Child Development, Development of Youth, Women's Empowerment, Welfare of aged, Welfare of Physically. Mentally and Social Handicapped, Welfare of backward Classes (SCs, STs and Other Backward Classes) Rural Development Urban Community Development, Medical And Psychiatric Social work, Industrial Social work, Social Security offender Reforms.

SUGGESTED READINGSS:

1. Rajni Bedi ,"Social Work: An Introductory Text Book", BHARAT BOOK CENTRE
2. Sanjay Bhattacharya ,"Social Work: An Integrated Approach ", Deep & Deep Publications
3. Nitesh Dhawan ,"Social work perspective Philosophy and Methods ",BHARAT BOOK CENTRE
4. P. R. Gautam ,"Social Work: Methods Practices And Perspectives", LAXMI PUBLICATIONS

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO011	Intellectual property and Patenting	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):

- The objective of this Course is to provide in-depth knowledge of the laws and process related to Trademarks, Copyrights and other forms of IPs with focus on Patents, the Indian and International Patent filing procedure, drafting patent application and conducting prior art searches. Students will be exposed to the technical, management and legal aspects of IP and Patents.

COURSE CONTENT:

UNIT I: Introduction: Historical and philosophical background of patents and other intellectual property, Patent System: the Constitution, Congress, Patent Office (PTO), and courts; Analyzing and understanding judicial opinions

UNITII: Comparative overview of patents, copyrights, trade secrets, and trademarks: Legal fundamentals of patent protection for useful inventions**,** Design and plant patents, Legal fundamentals of copyright protection, Similarity and access, Expression vs. ideas and information, merger, Fair use of copyrighted works (e.g., for classroom use), Contributory copyright infringement, Critical differences between patent and copyright protection, Copyright infringement distinguished from plagiarism, Legal fundamentals of trade-secret protection, Legal fundamentals of trademark protection

UNIT III: Requirements and limitations of patentability: New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.

UNIT IV: The process of applying for a patent ("patent prosecution"): Anatomy of a patent application, Adequate disclosure, The art of drafting patent claims, Patent searching: (A) Purposes and techniques, Actions for patent infringement, Interpretation of claims, Doctrine of equivalents, Product testing as a possibly infringing use, Doctrine of exhaustion.

SUGGESTED READINGSS:

Rines, Robert H., " Create or Perish: The Case for Inventions and Patents", Acropolis.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO012	Supply Chain Management and Logistics	3L-1T-0P	4	None

COURSE OUTCOMESS(CO):-

- Supply chain management consists of all parties (including manufacturer, marketer, suppliers, transporters, warehouses, retailers and even customers) directly or indirectly involved in fulfillment of a customer. The main objective is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for a business firm.

COURSE CONTENT:

Unit I

Introduction: Concept of supply chain management (SCM) and trade logistics; Scope of logistics; Logistic activities – an Overview; Contribution of logistics at macro and micro levels; SCM and trade logistics; Business view of SCM; Concept, span and process of integrated SCM; Demand management – methods of forecasting; Supply chain metrics (KPIs), performance measurement and continuous improvement; Product development Process and SCM; Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle.

Unit II

Managing Relationship: Role of Relationship marketing in SCM; Managing relationships with suppliers and customers; Captive buyers and suppliers; Strategic partnerships; Supplier-retailer collaboration and alliances.

Unit III

Focus Areas of Logistics and Supply Chain management: Transportation-Importance of effective transportation system; Service choices and their characteristics; inter-modal services; Transport cost characteristics and rate fixation; In-company management vs. out-sourcing; World sea borne trade; International shipping- characteristics and structure; Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Development in sea transportation-Unitization, containerization, inter and multimodal transport; CFC and ICD. Air transport: Set up for air transport and freight rates; Carriage of Goods by sea -Role and types of cargo intermediaries. Warehousing and inventory management: Reasons for warehousing; Warehousing evaluation and requirements; Warehousing location strategies; Inventory management principles and approaches; Inventory categories -EOQ, LT, ICC; Material management systems and techniques – JIT purchasing, manufacturing and in-bound logistics; Packing and marking; Control and communication.

Unit IV

IT Enabling Logistics and Supply Chain: Technology in logistics – EDI, bar Coding, RFID etc., data warehousing, electronic payment transfers; Business management systems; TRADITIONAL ERP, SPECIAL ERP, MR, DRP, PDM, EIP, CPFR, WMS, TMS; Re-engineering the supply chain- Future directions.

Unit V

Trends and Challenges in logistics and supply chain management: Third party logistic outsourcing –challenges and future directions.

SUGGESTED READINGSS:

1. Christopher, M.," Logistics and Supply Chain Management", Prentice Hall.
2. Handfield and Nicholas, Jr., "Introduction to Supply Chain Management", Prentice Hall.
3. Jhon J Coyle, C. Jhonand Langley, Brian J Gibs, "Logistics approach to Supply Chain Management", Cengage Learning.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO013	Organization Development	3L-1T-0P	4	None

COURSE OUTCOMESS:

- Organization Development is a growing field of Human Resource Management. It has its foundations in a number of behavioral and social sciences.

COURSE CONTENT:

1. Organizational Systems and Human Behavior - Developing a basic knowledge of how organizations and groups function as systems; introducing and discussing various theoretical approaches and issues.
2. Interpersonal and Consulting Skills - Increasing effectiveness as a change agent by providing a variety of opportunities in order to increase self-awareness, practice alternative ways of approaching personal and interpersonal problem-solving and develop basic consulting and interviewing skills.
3. Introduction to Organization Development - Introducing some basic theories, models and methods in the field of organization development, especially those relating to the role of consultant and strategies for change.
4. Intervention and Change in Organizations - Consolidating and further developing consulting skills and strategies
5. Action Research Project - Carrying out a change activity in an organization, while also researching the effects and/or the process. This provides participants with an opportunity to consolidate and demonstrate skills and knowledge gained in other units of the course.

SUGGESTED READINGSS:

1. Mee-Yan Cheung-Judge, Linda Holbeche, "Organization Development: A Practitioner's Guide for OD and HR", Kogan Page.
2. Lisa Haneberg, "Organization Development Basics (ASTD Training Basics)" , ASTD Press

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO014	Industrial organisation and managerial economics	3L-1T-0P	4	None

COURSE OUTCOMES:

This course help students in understanding the basics of management and Industrial organisation.

COURSE CONTENT:

Unit I: Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits.

Unit II: Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling , routing, despatching., Methods Study, Methods analysis, time study methods of rating.

Unit III: General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand forcasting of production analysis- prices and pricing decision-profit and capital, management. Analysis of inter-industry relation, macro-economics and business.

Suggested READINGSs:

1. KoutsoyiannisA , " Modern Microeconomics", Palgrave Macmillan.
2. D.N. Dwivedi, " Managerial Economics", S.Chand (G/L) & Company Ltd;
3. Maheshwari., "Managerial Economics", PHI

4. Ruddardutt and K.P.M.Sundharam, " Indian economy", S Chand

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO015	Global Strategies and Technology	3L-1T-0P	4	None

COURSE OUTCOMESS

- This subject focuses on the specifics of strategy and organization of the multinational company, and provides a framework for formulating successful and adaptive strategies in an increasingly complex world economy.

COURSE CONTENT:

Globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, and building global networks.

Analysis of competitive situations from the general management point of view, including fit between key environmental forces and the firm's resources, and changes in these over time. Formulating and implementing strategy based on that analysis. Developing and leveraging a firm's core competencies to gain long-term sustainable advantage.

SUGGESTED READINGSS:

1. Mike W. Peng, "Global strategy", South-Western College Pub.
2. Pankaj Ghemawat, "Redefining Global Strategy", Harvard Business Review Press
3. Cornelis A. de Kluyver, "Fundamentals of Global Strategy", Business Expert Press.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO016	Engineering System analysis and Design	3L-1T-0P	4	None

COURSE OUTCOMES:

- The students will learn about system definitions and role of system analyst. They will learn about system modeling and design. They will be exposed to System Implementation and Maintenance issues.

COURSE CONTENT:

Unit 1

System definition and concepts: Characteristics and types of system, Manual and automated systems

Real-life Business sub-systems: Production, Marketing, Personal, Material, finance Systems models types of models: Systems environment and boundaries, Real time and distributed systems, Basic principles of successful systems

Unit 2

Systems analyst: Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst, agent of change.

Various phases of systems development life cycle: Analysis, Design, Development, Implementation, Maintenance

Unit3

Systems Design and modeling: Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems

Unit 4

User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.

Unit 5

System Implementation and Maintenance: Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems qualify Control

and assurance, Maintenance activities and issues.
SUGGESTED READINGSS: 1) Haryszkiewycz, "Introduction to Systems Analysis and Design", II Ed. PHI . 2) James A Senn : "Analysis and Design of Information Systems", McGraw Hill .

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO017	**BIOLOGY FOR ENGINEERS**	**3L-1T-0P**	**4**	**None**

COURSE OUTCOMESS:

1. General understanding of organization in biological systems
2. Conceptual knowledge of functioning in biological systems
3. Clarity about relevance of Biology to engineering graduates
4. Understanding human body as a study-model for engineering students
5. Understanding electrical, chemical and magnetic forces, and communication networks in human body.

COURSE CONTENT:

Unit I: Principles of Biology: Form and Function, Modularity and Incremental Changes, Genetic Basis, Competition and Selection, Biological Hierarchies, Biological complexity vs simplicity

Unit II: Biological Responses: Need for Water, Oxygen, Food, Nutrients, Heat Sources and Sinks, Adaptation to their Environments, Waste tolerance, Response to Chemical and Mechanical Stresses, Optimization to Save Energy and Nutrient Resources, **Allometric Relationships from Evolutionary Pressure**

Biology for Engineering Solutions: Systems Approach, Relationships between Engineering and Biology, The Completed Design

Biological Systems and Dynamics: Basic principles, Qualitative and quantitative description of Human Body, Modeling of Human Body: Compartments, Fluid streams, Production sources, The Hemodynamic System, Cheyne-Stokes Respiration,

Neural system: Action Potentials and Ion Channels, Ficks Law, Ohms Law and the Einstein Relation, Cellular Equilibrium: Nernst and Goldman, Equivalent Circuits, Dendrites; **Mathematical Neurodynamics:** Hodgkin, Huxley and the Squid Giant Axon FitzHugh-Nagumo Model, Fixed Points and Stability of a One-Dimensional Differential Equation, Nullclines and Phase Plane, Pitchfork and Hopf Bifurcations in Two Dimensions Excitability, Bioelectric and biomagnetic phenomena and their measurements.

SUGGESTED READINGSS:

1. T. Johnson ,"Biology for Engineers", CRC Press.
2. Michael Small,"Dynamics of Biological system", CRC Press.
3. Johnny T. Ottesen, MS Olufsen, JK Larsen Applied Mathematical Models and Human Physiology", Society for Industrial and Applied Mathematics.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO018	**Energy, Environment and Society**	**3L-1T-0P**	**4**	**None**

COURSE OBJECTIVE:

The objective is to aware students about various renewable resources, Basics of energy, environmental Impact of Energy sources. Students will also learn about the role of appropriate Technology in Transformation of Society**.**

COURSE CONTENT:

Unit 1 Technology and Development

Introduction to Technology, Appropriate Technology, Role of Appropriate Technology in Transformation of Society, Importance of Technology Transfer, Impact of technology on Society.

Unit 2 Energy Basics

Importance of Energy in achieving Maslow's hierarchy of Needs, Human Development Index and Energy Consumption, Current Energy Trends, Demand and Supply of Energy in World and Nepal, Introduction to Global warming, Clean Development Mechanism, and Sustainability Issues, Conventional and Non-Conventional/Renewable Energy Sources,. Conventional Energy Sources: Fossil fuel, Nuclear Energy

Unit 3 Renewable Energy Sources

Solar radiation, Solar thermal energy, Solar Cell (Photovoltaic Technology), Hydropower Water sources and power , Water turbines and hydroelectric plants, Hydro Power Plant Classification (pico, micro, small, medium, large), Wind Energy , Availability of Wind Energy sources, Wind turbines, wind parks and power control, Geothermal Energy, Sources of Geothermal Energy, Uses of Geothermal Energy, .Bio-mass and Bio-energy, Synthetic fuels from the biomass ,Thermo-chemical, physio-chemical and bio-chemical conversion, Bio-fuel cells , Hydrogen Energy and Fuel Cell , Basics of electrochemistry, Polymer membrane electrolyte (PEM) fuel cells, Solid oxide fuel cells (SOFCs) , Hydrogen production and storage.

Unit 4 Environmental Impact of Energy sources

Emission hazard, Battery hazard, Nuclear hazard

Unit 5 Energy Storage

Forms of energy storage, Hybrid vehicles, Smart grid systems, Batteries, Super-capacitors

SUGGESTED READINGSS:

1) Saxena, A.B.," A Textbook of Energy, Environment, Ecology and Society ",Home New Society Publisher
2) Juan Martinez-Alier and Klaus Schlupmann.,"Ecological Economics: Energy, Environment and Society ," Blackwell Publishers

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO019	Public Policy and Governance	3L-1T-0P	4	None

COURSE OBJECTIVE:

- Students will be introduced to Public Policy and administrative governance. They will also learn about Administrative Governance.

COURSE CONTENT:

Unit 1 Introduction to Public Policy and Administrative Governance: Introduction to public policy, econometrics for policy research, policy analysis, economics for public decision making.

Unit 2 Public Bureaucracy in Theory and Practice: Benefit cost analysis, public budgeting, revenue and expenditures, managing and leading public service organizations.

Unit 3 Administrative Governance: The Challenge of Policy Implementation, public and non-profit programme evaluation.

Unit 4 Non-state Actors in Policy-making and Administrative Governance: governance in twenty-first century, Social Diversity and the Question of "Difference" in Policy-making and administrative Governance.

SUGGESTED READINGSS:

1. John Shields and B. Mitchell Evans, "Shrinkingthe State: Globalization and Public administration Reform." Halifax: Fernwood.

2. Beryl Radin," Beyond Machiavelli: Policy Analysis Reaches Midlife", Washington, DC: Georgetown University Press.

3. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball ," Lobbying and Policy Change: Who Wins, Who Loses, and Why. Chicago, IL", University of Chicago Press.

4. Timothy Conlan, Paul Posner, and David Beam ," Pathways of Power: The dynamics of National Policymaking" Washington, DC: Georgetown University press.