Narasaraopeta Engineering College (Autonomous)

Kotappakonda Road, Yellamanda (P.O), Narasaraopet- 522601, Guntur District, AP.

Sponsored by Gayatri Educational Development Society, Narasaraopet.

Approved by AICTE, New Delhi & Permanently affiliated to JNTUK, Kakinada. Code: 47.

Twice Accredited by NBA & NAAC with “A” Grade; ISO 9001:2008 Certified Institution.

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**R19 M.Tech**

**ACADEMIC REGULATIONS**

 **ACADEMIC REGULATIONS - 2019 FOR M.TECH**

**(Effective for the students admitted into I year from the Academic Year 2019-20 and onwards)**

1. **QUALIFICATION FOR ADMISSION**

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit / rank obtained by the candidates at the qualifying entrance test GATE/PGECET or on the basis of any other order of merit as approved by the Government from time to time.

1. **AWARD OF M.TECH. DEGREE**

A student will be declared eligible for the award of the M. Tech. Degree, if he fulfils the following academic requirements.

1. Pursue a course of study for not less than two academic years and not more than four academic years.

(b) The candidate registers for 80 credits and secure all 80 credits.

1. **COURSES OF STUDY**

The following courses of study are offered at present as specializations in the

M.Tech. courses with English as medium of instruction.

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Specialization Code** | **Abbreviation** |
| 01 |  06 - DSCE | Digital Systems and Computer Electronics |
| 02 |  15 - MD | Machine Design |
| 03 |  21 - TE | Thermal Engineering |
| 04 |  38 - DECS | Digital Electronics and Communication Systems |
| 05 |  42 - P&ID | Power and Industrial Drives |
| 06 |  58 - CSE | Computer Science and Engineering |
| 07 |  87 - SE | Structural Engineering |

 And any other course as approved by the authorities from time to time.

1. **STRUCTURE OF THE PROGRAMME**

|  |  |
| --- | --- |
| **Semester** | **Credits** |
| I M.TECH I SEM | 21 |
| I M.TECH II SEM | 21 |
| II M.TECH III SEM | 38 |
| II M.TECH IV SEM |
| TOTAL | 80 |

 Each course is normally assigned a certain number of credits as follows:

- 3 credits for 4 lecture periods.

- 3 credits for 6 laboratory periods per week.

- 1 credit for seminar.

- 2 credits for comprehensive viva

- 35 credits for project work.

**5. DISTRIBUTION AND WEIGHTAGE OF MARKS**

The performance of the candidate in each semester shall be evaluated subject wise, with a maximum of 100 marks for theory / practical / seminar / comprehensive viva on the basis of internal evaluation and end semester examinations.

**5.1 THEORY**

All theory subjects consisting of 6 units in each subject, the assessment shall be for 40 marks through internal evaluation and 60 marks through external end semester examination of 3 hours duration.

 **5. 1.a. INTERNAL EVALUATION**

The internal evaluation will be based on two cycle tests conducted in each semester. The 40 internal marks will be awarded as 75% of the best cycle and 25% of the least cycle examinations, where each cycle of examination contain

Descriptive test - 30 Marks

Assignment test - 10 Marks

Each descriptive test question paper contains3 questions one from each unit covering syllabus from 3 units (first 3 units for first cycle and the remaining 3 units for second cycle). The student has to answer all the three questions (3X10M=30M).The descriptive examination will be conducted for1½ hour duration.

In Assignment Tests 5 or 6 questions will be declared in the class room at least one week in advance. In the test, two questions (one from each unit) will be given at random to each student and the student has to answer it.

The Assignment Test-1 will be conducted for 10 marks covering the syllabus from
1st& 2ndunits.The Assignment Test-2 will be conducted for 10 marks from 4th& 5th units.

**5.1.b. EXTERNAL EVALUATION**

The question paper comprises of 8 questions, there should be one from each unit. Student has to answer 5 questions out of 8, each question carry 12marks (5X12=60). The duration of end theory examination is 3 hours.

**5.2 PRACTICALS**

For practical subjects evaluation is as follows during the semester

**5.2. a. INTERNAL EVALUATION**

There shall be continuous evaluation during the semester for 40 internal marks. The internal marks shall be awarded as follows:

Record - 10 Marks

Day-to-day work - 15 Marks

Internal Lab Test - 15Marks

**5.2. b. EXTERNAL EVALUATION**

For practical subjects there shall be an external examination at the end of the semester for 60 marks in the presence of external examiner.

**5.3** A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the end semester examination and a minimum of 50% of the total marks in the end semester examination and internal evaluation taken together.

**5.4 SEMINAR**

For seminar, a student under the supervision of a faculty member shall collect the literature on an advanced topic related to his specialization and review the literature then submit it to the department in a report form during the third semester and shall make an oral presentation before the departmental review committee consisting of the supervisor and head of the department / a senior faculty member. There shall be an internal evaluation for 100 marks in the form of viva voce examination and assessment of report and its presentation. There will be NO external evaluation. A candidate shall be deemed to have secured the minimum academic requirement in seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and he has to submit a fresh report and appear for the evaluation by the committee.

**5.5 COMPREHENSIVE VIVA-VOCE**

Comprehensive viva voce examination is conducted during the 3rd semester in all the subjects of first & second semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

A candidate shall be deemed to have secured the minimum academic requirement in seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and undergo viva voce examination.

**5.6** In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.3) he has to re-appear for the end semester examination in that subject.

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate is less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate’s attendance in the re-register subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks in the previous attempt stand cancelled. For re-registration the candidates have to apply to the college by paying the requisite fee and get approval from the authorities before the beginning of the semester in which re-registration is required.

**5.7** In case the candidate secures less than the required attendance in any re-registered subject(s), he shall not be permitted to write the End examination in that subject. He shall again re-register the subject when next offered.

**5.8** Laboratory examinations must be conducted with two examiners, one of them being the laboratory class teacher or teacher of the respective college and the second examiner shall be appointed by the Principal from the panel of examiners submitted by the respective departments.

**5.9 PROJECT WORK**

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

5.9.1. A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

5.9.2. Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

5.9.3. After satisfying 5.9.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The students can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

5.9.4. If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the Project Review Committee (PRC) shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of supervisor or topic as the case may be.

5.9.5. A candidate shall submit his status report in two stages at least with a gap of 3 months between them.

5.9.6. The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical subjects with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

5.9.7. Three copies of the Project Thesis certified by the supervisor shall be submitted to the College.

5.9.8. The thesis shall be adjudicated by one examiner selected by the authorities. For this, the HOD of the concerned dept. shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned.

5.9.9. If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

5.9.10. If the report of the examiner is favourable, viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the thesis. The Board shall jointly report the candidate’s work as one of the following: Grade O(Outstanding)/ Grade A(Excellent)/Grade B(Very Good) /Grade C(Good)/ Grade D(Pass)/ Grade F(Fail).

 The Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination.

5.9.11. If the report of the viva-voce is Grade F, the candidate shall retake the viva-voce examination only after three months. If he fails to get a satisfactory report at the second viva-voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

**6. ATTENDANCE REQUIREMENTS:**

(i) A student shall be eligible to appear for the end examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

(ii) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester for genuine medical reasons and shall be approved by a committee duly appointed by the college. A fee stipulated by the college shall be payable towards condonation of shortage of attendance. However the number of condonations is restricted to two for the entire course.

(iii) A student who is short of attendance in a semester may seek re-admission into that semester when offered next time, within 4 weeks from the date of commencement of class work.

(iv) If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for re-admission into the same class.

**7. COURSE PATTERN:**

(i) The entire course of study is of two academic years and every year will have TWO Semesters.

(ii) A student is eligible to appear for the end examination in a subject, but absent for it or has failed in the end examinations may appear for that subject in supplementary examinations, when conducted next.

(iii) When a student is detained due to shortage of attendance, he may be re-admitted in to the same semester/year in which he has been detained.

**8. METHOD FOR AWARDING OF GRADE POINTS FOR A SUBJECT:**

|  |  |  |
| --- | --- | --- |
| **Theory/ Laboratory / Seminar/ Comprehensive viva/ Project (% of marks in a subject)** | **Corresponding Grade Points** | **Letter Grade** |
| 91 - 100 | 10 | O (Outstanding) |
| 81 - 90 |  9  | A (Excellent) |
| 71 - 80 |  8  | B (Very Good) |
| 61 - 70 | 7 | C (Good) |
| 51 - 60 |  6  | D (Pass) |
| < 50 |  0 | F (Fail) |

**9. Criteria for award of grades/division.**

**9.1 Calculation of Semester Grade Point Average (SGPA)\* for semester**

The performance of each student at the end of each semester is indicated in terms of SGPA. The SGPA is calculated as given below:

 SGPA=

 Where CR= Credits of a subject

 GP = Grade Points awarded for a subject

 \*SGPA is calculated for a candidate who passed all the subjects in that semester.

**9.2 Calculation of Cumulative Grade Point Average (CGPA) for Entire Program:**

The CGPA is calculated as given below:

CGPA=

Where CR = Credits of a subject

 GP = Grade Points awarded for a subject

* The SGPA and CGPA shall be rounded off to 2 decimal point and reported in the transcripts.
* Equivalent percentage = (CGPA – 0.75) x 10

**9.3 Award of Division:**

After satisfying the requirements prescribed for the completion of the program, the student shall be eligible for the award of M.Tech Degree and shall be placed in one of the following classes:

|  |  |
| --- | --- |
| **CGPA** | **Class** |
| ≥ 7.75 | First Class with Distinction (Provided all the subjects should pass in the first attempt) |
| ≥ 6.75  | First Class (with subject failures) |
| ≥ 5.75 & < 6.75 | Second Class |

**10. REVALUATION:**

1. Student can submit the application for revaluation, along with the prescribed fee for revaluation of his answer script(s) of theory subject(s) as per the notification issued by the Controller of Examinations.
2. The Controller of Examinations shall arrange for revaluation of such answer script(s).
3. An External examiner, other than the first examiner shall revaluate the answer script(s).

**11**. **MINIMUM INSTRUCTION DAYS:**

The minimum instruction days for each semester shall be 90 working days.

**12**. There shall be no branch transfer after the completion of admission process.

**13. WITHHOLDING OF RESULTS**

If the student has not paid the dues, if any, to the college or if any case of indiscipline is pending against him, the result of such student will be kept withheld. His degree will be withheld in such cases.

**14. TRANSITORY REGULATIONS**

Discontinued or detained candidates are eligible for readmission as and when next
offered.

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the subjects in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such subjects in the earlier semester(s) he was originally admitted into and substitute subjects are offered in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

**14.1** A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the subjects prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

**14.2** A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects will be offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects up to previous semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree will be sum of the credits up to previous semester under JNTUK regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

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**MALPRACTICES RULES**

**DISCIPLINARY ACTION FOR / IMPROPER CONDUCT INEXAMINATIONS**

* The Principal shall refer the cases of Malpractices in Internal Assessment Test and Semester end examinations to a malpractice prevention committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the students based on the recommendations of the committee.
* Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder:

|  |  |  |
| --- | --- | --- |
|  | **Nature of Malpractices/****Improper conduct** | **Punishment** |
|  | *If the candidate:* |  |
| 1(a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination). | Expulsion from the examination hall and cancellation of the performance in that subject only. |
| 1(b) | Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2. | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the college. |
| 3. | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him. |
| 4. | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5. | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject. |
| 6. | Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-incharge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s)has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. |
| 7. | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8. | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. |
| 9. | If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6to 8. | Student of the college expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to police and, a police case will be registered against them. |
| 10. | Comes in a drunken condition to the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. |
| 11. | Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny. | Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations. |
| 12. | If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the college for further actionto award suitable punishment. |  |

**OTHER MATTERS:**

1. Physically challenged candidates who have availed additional examination time and a scribe during their UG / PGECET examinations will be given similar concessions on production of relevant proof / documents.
2. The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the departments shall be reported to the Academic Council for ratification.

**GENERAL:**

1. The academic council may, from time to time, revise, amend or change the regulations, schemes of examinations and / or syllabi.
2. Wherever the words ‘’he’’ ‘’him’’ ‘’his’’, occur in the regulations, they include ‘’she’’, ’’her’’, ’’hers’’.
3. The academic regulation should be read as a whole for the purpose of any interpretation.
4. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the principal is final.

**R19-COURSE STRUCTURE**

**M.Tech-POWER & INDUSTRIAL DRIVES**

**I M. TECH. - I SEMESTER**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S. No. | Subject | L | T | P | InternalMarks | ExternalMarks | Total Marks | Credits |
| 1 | Electrical Machine Modelling and Analysis | 3 | - | - | 40 | 60 | 100 | 3 |
| 2 | Distributed generation and its impacts | 3 | - | - | 40 | 60 | 100 | 3 |
| 3 | Analysis of Power Electronic Converters and Inverters  | 3 | - | - | 40 | 60 | 100 | 3 |
| 4 | Flexible AC Transmission System | 3 | - | - | 40 | 60 | 100 | 3 |
| 5 | **Elective – I**1. Power Semiconductor Devices and protection
2. Energy Management and Auditing
3. Micro controller and its Applications
 | 3 | - | - | 40 | 60 | 100 | 3 |
| 6 | **Elective – II**1. Reactive Power Compensation and Management
2. Special Machines and Control
3. Modern Control Theory
 | 3 | - | - | 40 | 60 | 100 | 3 |
| 7 | Power Electronics System Simulation Lab | - | - | 6 | 40 | 60 | 100 | 3 |
|  | Total | 18 | - | 6 | 280 | 420 | 700 | **21** |

L: Lecture

T: Tutorial

P: Practical

**I M. TECH. - II SEMESTER**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S. No. | Subject | L | T | P | InternalMarks | ExternalMarks | Total Marks | Credits |
| 1 | Control of DC and AC Drives | 3 | - | - | 40 | 60 | 100 | 3 |
| 2 | Soft Computing Techniques | 3 | - | - | 40 | 60 | 100 | 3 |
| 3 | Power Electronics inRenewable EnergySystems | 3 | - | - | 40 | 60 | 100 | 3 |
| 4 | Power System Deregulation  | 3 | - | - | 40 | 60 | 100 | 3 |
| 5 | **Elective – III**1. Smart Grid
2. Power Quality
3. Power System Stability
 | 3 | - | - | 40 | 60 | 100 | 3 |
| 6 | **Elective – IV**1. Custom Power Devices
2. Digital Control Systems
3. High Voltage DC Transmission
 | 3 | - | - | 40 | 60 | 100 | 3 |
| 7 | Power Converters Lab | - | - | 6 | 40 | 60 | 100 | 3 |
|  | Total | 18 | - | 6 | 280 | 420 | 700 | **21** |

**II M. TECH. – III & IV SEMESTERS**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. NO.** | **NAME OF THE SUBJECT** | **Total Marks** | **Credits** |
| 1 | Seminar | 100 | 1 |
| 2 | Comprehensive Viva-Voce | 100 | 2 |
| 3 | Project | - | 35 |
|  | Total | **200** | **38** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **I M.TECH****I SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1TH01** | **ELECTRICAL MACHINE MODELING AND ANALYSIS** |

**COURSE OBJECTIVES:**

* The objective is to understand the representation of the Kron’s Primitive Machine, respective Two pole representation and different equations
* To understand the mathematical modeling of DC machines
* To understand the Transformation Techniques and circuit models
* To understand the modeling and control of 3-phase and 1-phase Induction machines
* To understand the control and mathematical models of Synchronous Machines
* To understand the concept of modeling and control of Special Electrical Machines

**COURSE OUTCOMES**:

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

1. Derive Kron’s Primitive machine as a unified electrical machine model.
2. Derive the mathematical model of a separately excited DC motor & Self Excited DC
 Motor.
3. Derive linear transformation and Active Transformation Techniques.
4. Derive the mathematical model and control a 3- phase & 1-phase Induction motor under
 transient /steady state conditions.
5. Analyze the mathematical model and control of synchronous Machines.
6. Analyze mathematical model of BLDC ,SRM &special Electrical machines

**UNIT I: Basic Concepts of Modeling**

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron‟s primitive Machine-voltage, current and Torque equations.

**UNIT II: Modeling of DC Machines**

Mathematical model of separately excited DC motor in state variable form – Transfer function - Numerical problems. Mathematical model of D.C. Shunt motor, DC Series motor and D.C. Compound motor in state variable form - Transfer function - Numerical Problems

**UNIT III: Transformation Techniques**

Linear transformation-Phase transformation (a -b -c to a -p -o)-Active transformation(a -p -o to d -q)- Circuit model of a 3 phase Induction motor - Linear transformation - Phase Transformation - Transformation to a Reference frame - Two axis models for Induction motor

**UNIT IV: Modeling of Three Phase Induction Machine**

D-Q model of induction machine in Stator reference Frame, Rotor reference Frame and Synchronously rotating reference Frame -Small signal equations of induction machine-d-q flux Linkages model derivation- Signal flow graph of the induction machine-Per unit model –Dynamic Simulation of induction machine.

**Modeling of Single Phase Induction Machine**

Comparison between single phase and poly-phase induction motor - Cross field theory of single phase induction machine, steady state analysis – steady state torque

**UNIT V: Modeling of Synchronous Machine**

Synchronous machine inductances –The phase Co-ordinate model-The Space phasor (d-q) model- Steady state operation-Mathematical model of PM Synchronous motor

**UNIT VI: Modeling of Special Machines**

Modeling of Permanent Magnet Brushless DC Motor – Operating principle-Mathematical modeling of PM Brushless DC motor-PMDC Motor Drive Scheme. Mathematical model of Switched Reluctance Motor-Operating principle-Construction and functional Aspects-Average torque and Energy Conversion Ratio-The Commutation windings- SRM modeling-The flux current position curve fitting.

**TEXT BOOKS:**

1. Analysis of Electrical machinery and Drive Systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff –IEEE Press – 3rd Edition 2013.
2. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995

**REFERENCE BOOKS:**

1. Electric Motor Drives Pearson Modeling, Analysis& control -R. Krishnan- Publications-1stedition -2002
2. The Unified Theory of Electrical Machines by C.V.jones, Butterworth- London, 1967
3. Dynamic simulation of Electric machinery using Matlab/ Simulink –CheeMunOng –Prentice Hall Publications-1998.

**WEB REFERENCES:**

1. URL: https://nptel.ac.in/courses/108106023/

2. URL:https://www.youtube.com/watch?v=AECBgmkWvo0&list=PLbMVogVj5nJQBG9363J1uq5Fnq4

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| **I M.TECH****I SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1TH02** | **DISTRIBUTED GENERATION AND ITS IMPACTS** |

**COURSE OBJECTIVES:**

* To understand the renewable energy systems
* To study the Economics of renewable energy generation
* To Identify the optimal location of Distributed generation
* To study the Impact of Distributed Generation

**COURSE OUTCOMES:**

1. An ability to use research-based knowledge and research methods including design of experiments,
2. Analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
3. An ability to create, select, and apply appropriate techniques, resources, and modern engineering tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
4. An ability to understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**UNIT-I: Introduction**

Renewable Sources of Energy- Grid-Supplied Electricity-Distributed Generation-Renewable Energy Economics-Calculation of Electricity Generation Costs –Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

**Wind Power Plants:**

Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose of the Energy Generated -General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines -Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy -Analysis of Small Generating Systems.

**UNIT-II: Photovoltaic Power Plants**

Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parameters for Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy.

**UNIT-III: Fuel Cells**

The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues-Constructional Features of Proton Exchange-Membrane Fuel Cells –Reformers- Electro lyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit-Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel.

**UNIT-IV: Storage Systems**

Energy Storage Parameters – Lead–Acid Batteries-Ultra Capacitors-Flywheels-Superconducting Magnetic Storage System-Pumped Hydroelectric Energy Storage- Compressed Air Energy Storage -Storage Heat -Energy Storage as an Economic Resource.

**UNIT-V: Integration of Alternative Sources of Energy**

Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach Integration of Multiple Renewable Energy Sources-Islanding and Interconnection Control-DG Control and Power Injection.

Interconnection of Alternative Energy Sources with the Grid:

Interconnection Technologies -Standards and Codes for Interconnection-Interconnection Considerations -Interconnection Examples for Alternative Energy Sources.

**UNIT-VI: Impact of Distributed Generation**

Biomass – Small Hydro – Generation Technology – Environmental impact – Cost benefits – Optimal location of Distributed Generation, Impact of Distributed Generation on Voltage profile – Equipment Loading – Losses – Short Circuit Level – Stability – Protection and Relay Coordination – Harmonic and Power Quality.

**TEXT BOOKS:**

1. Felix A. Farret, M. Godoy Simoes, ―Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Solanki: Renewable Energy Technologies: Practical Guide For Beginners, PHI Learning Pvt. Ltd., 2008.

**REFFERENCE BOOKS:**

1. D. Mukherjee: Fundamentals Of Renewable Energy Systems, New Age International publishers, 2007.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.
3. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

**WEB REFERENCES:**

1. URL: https://www.sciencedirect.com/science/article/pii/S1876610212011757

2. URL: https://www.sciencedirect.com/book/9780128002407/distributed-generation-and-its-implications-

 for-the-utility-industry

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| **I M. TECH****I SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1TH03** | **analysis of power electronic converters & INVERTERS** |

**COURSE OBJECTIVES:**

* To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
* To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
* To analyse and comprehend the various operating modes of different configurations of power converters.
* To apply switching techniques and basic topologies of resonant converters.

**COURSE OUTCOMES:**

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

1. Acquire and apply knowledge of mathematics for the analysis of power converters.
2. Capable to model, analyze and explicate the power electronics systems
3. Expertise in the working modes and operation of power converters.
4. Design a Resonant Converter.

**Unit-I: Single Phase AC-DC Converter**

Half controlled and Fully controlled converters with RL-RLE loads and freewheeling diode-continuous and discontinuous modes of operation-inverter operation-Dual converter-Sequence control of converters-Performance parameters: harmonics-ripple-distortion-power factor-effect of source impedance.

**Unit-II: Three Phase AC-DC Converter**

Semi and fully controlled converter with R-RL-RLE loads and freewheeling diodes-inverter operation and its limit-performance parameters-effect of source impedance-dual converters.

**Unit-III: DC-DC Converters**

Principles of step-down and step-up converters –Analysis and design of Buck-boost-buck boost converter and CUK converters-time ratio and current limit control-resonant and quasi-resonant converters.

**Unit-IV: AC Voltage Controllers**

Principle of operation of half and full bridge inverters-performance parameters-1800 and 1200

Conduction mode inverters with star and delta connected loads-voltage control of three phase inverters using various PWM techniques.

**Unit-V: Cycloconverters**

Principle of operation of AC voltage controllers-analysis with R and RL loads- single phase and three phase cycloconverters.

**Unit VI Resonant Converters**

Soft switching concepts in DC-DC Converters – ZVS and ZCS concepts – Design of Boost rectifiers for different types of PWM – high frequency quasi resonant DC-DC Converters -SVPWM schemes for AC voltage controllers.

**TEXT BOOKS:**

* + - 1. M.H. Rashid, Power Electronics: Circuits, Devices and Application, New Delhi, Prentice Hall of India, 2010.
			2. Ned Mohan, Tore M. Undeland and William Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2007.
			3. P.C Sen, Modern Power Electronics”, Wheeler publishing, first edition, New Delhi-1998
			4. Jai Agarwal, “Power Electronics systems”, Pearson Education, second edition,2002

**REFERENCE BOOKS:**

* + - 1. Hua Bai, Chris Mi, Transients of Modern Power Electronics, John Wiley & Sons, 2011
			2. M.H. Rashid, Hand Book of Power Electronics: Circuits, Devices and Application, New Delhi, Prentice Hall of India, 2007.
			3. Marty Brown, Power sources and supplies Newnes, Elsevier, Second edition,2010.
			4. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education, Second Edition 2003
			5. P.S. Bimbra, “power Electronics”, Khanna Publishers, Eleventh Edition, 2003.

**WEB RESOURCES:**

1. http://www.infocobuild.com/education/audio-video courses/electronics/PWMFor

PowerElectronicConverters-IISc-Bangalore/lecture-01.html

1. https://nptel.ac.in/courses/108108035/

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| **I M.TECH****I SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1TH04** | **FLEXIBLE A.C. TRANSMISSION SYSTEMS** |

**COURSE OBJECTIVES:**

* Understand the basic concepts of real and reactive power flow and control in transmission lines.
* Emphasize the importance of voltage and Reactive power control in electrical systems.
* State different compensation techniques through FACTS devices.
* Understand different classification and importance of FACTS controllers.

**COURSE OUTCOMES:**

After completion of the course student will be able to

1. Explain the concept and working principles of various FACTS devices.
2. Analyze various control schemes used for UPFC
3. Utilize the steady state model of static voltage regulators
4. Choose appropriate FACTS controllers for power system applications.

**UNIT-I: Introduction to FACTS**

FACTS Concepts: Transmission interconnections, power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

**UNIT-II: Voltage Source and Current Source Converters**

Voltage source converters: Single phase three phase full wave bridge Converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

**UNIT-III: Shunt Compensation**

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

**UNIT- IV: Series Compensation**

Principles of static series compensation using GCSC, TCSC, TSSC configurations, characteristics, control- applications

**UNIT-V: Voltage Regulators**

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

**UNIT-VI: Unified Power Flow Controller (UPFC)**

Basic Operating Principles, Conventional Transmission Control Capabilities, Independent Real and Reactive Power Flow Control, Basic Control system for P and Q Control

**TEXT BOOK:**

1. N.G. Hingorani & L.Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 1999.

**REFERENCES BOOKS:**

1. X.P. Zang, C. Rehtanz and B. Pal, Flexible AC Transmission Systems: Modeling and Control, Birkhauser, 2006.
2. Y. H. Song and A. T. Johns, Flexible AC Transmission Systems, IET, 1999.

**WEB REFERENCES:**

1. https://www.electrical4u.com/facts-on-facts-theory-and-applications/

2. https://www.elprocus.com/flexible-ac-transmission-system-need-definition-types/

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| **I M.TECH****I SEMESTER****(Elective - I)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1PE05** | **POWER SEMICONDUCTOR DEVICES AND PROTECTION** |

**COURSE OBJECTIVES**:

* To understand various static and dynamic performances of static switches.
* To familiarize the student on switching and steady state characteristics power electronic devices.
* To analyze the control circuits and switching losses associated with the circuits.
* To emphasize the need for protection and thermal management.

**COURSE OUTCOMES**:

Upon completion of the course the students are ready to

1. Design switching using power semiconductor devices.
2. Specify design criteria (power, efficiency, ripple voltage and current, harmonic
 distortions, power factor) for a given application.
3. Select components; interpret terminal characteristics of the components, model
 components, design circuit, and understanding operation of power electronics circuits.
4. Design the heat sink for better performance of the circuit

**UNIT–I: Overview of Power Switching Devices**

Introduction to power switching devices, classification of devices, controlled and un-controlled devices, i-v characteristics of ideal and real switching devices.

**UNIT–II: Power Diodes**

Device structure and i-v characteristics, ratings & specifications, switching characteristics, reverse recovery, classification of various diodes: Schotky diode, line frequency diodes, and fast recovery diodes.

**Power Transistors:** Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

**UNIT–III: Power MOSFETs**

Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

**IGBT:** Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON toOFF and OFF to ON state transitions, ON/OFF transition loss analysis, Comparison of all the above devices with reference to power handling capability, frequency of operation, driver circuit, .emerging power switching devices.

**UNIT – IV: Protection of the Switching Devices**

Device protection against over voltage/currents, di/dt and dv/dt; safe operating area, Design of snubber circuit for power devices.

**UNIT – V: Thermal Management**

Conduction and transition losses computation, thermal model of the device, steady-state temperature rise, electrical equivalent circuit of thermal model, sizing of the heat sink.

**UNIT – VI: Passive Components**

Magnetic circuit, review of design of line frequency inductors and transformers, design of high frequency inductors and transformers.

**TEXT BOOKS:**

1. Power Electronics Circuits- B. W. Williams

**REFERENCE BOOKS:**

1. Power Electronics Circuits, Devices and Applications – M. H. Rashid-PHI-
2. Power Electronics –Converters, Applications and Design – Mohan and Undeland-John Wiley & Sons. Power Electronics: L. Umanand

**WEB REFERENCES:**

1. https://www.oreilly.com/library/view/power-electronics and/9780128118146/XHTML/B978012811798900010X/sec-s0210.xhtml

2. <https://www.allaboutcircuits.com/technical-articles/a-review-on-power-semiconductor-devices/>

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| **I M.TECH****I SEMESTER****(Elective – I)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1PE06** | **ENERGY MANAGEMENT AND AUDITING** |

**COURSE OBJECTIVES:**

• To introduce the basic concepts of Energy Auditing and Management.

• To familiarize the various Techniques of Electrical Energy Conservation.

**COURSE OUTCOMES:**

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

1. Explain the Process of Energy Audit of Industries.
2. Apply the concepts of Energy management for Efficient Energy Utilization and
 Conservation.
3. Identify a suitable method for Energy Conservation of various electric devices.
4. Analyze the benefits of energy conservation from the Economic aspects.

**UNIT-I: Basic Principles of Energy Audit**

Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

**UNIT-II: Energy Management**

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manger, Qualities and functions, language, Questionnaire – check list for top management.

**UNIT-III: Energy Efficient Motors**

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS voltage variation-voltage unbalance- over motoring- motor energy audit.

**UNIT - IV: Power Factor Improvement**

Power factor – Reasons for poor power factor-Significance of Power factor-methods of Power factor improvement- location of capacitors- Power factor with non-linear loads-effect of harmonics on power factor- power factor motor controllers

**UNIT - V: Lighting and Energy Instruments**

Good lighting system design and practice- lighting control -lighting energy audit – Energy. Instruments- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC’s.

**UNIT - VI: Economic Aspects and Analysis**

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

**TEXT BOOKS**

1. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o’ Callaghan, Mc-graw Hill Book company-1st edition, 1998

**REFERENCE BOOKS**

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd2nd edition,1995.
2. Energy management hand book by W.C.Turner, John wiley and sons.
3. Energy management and good lighting practice: fuel efficiency- booklet12EEO.

**WEBREFERENCES**

1. https://beeindia.gov.in/sites/default/files/1Ch3.pdf

2. http://www.emanz.org.nz/energy-management-audits

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| **19MPI1PE07** | **MICROCONTROLLER AND ITS APPLICATIONS** |

**COURSE OBJECTIVES:**

At the end of the course students are expected to

* Understand design and interfacing of microcontroller-based embedded systems.
* Write program in assembly level programs for MCS and PIC family microcontrollers
* Embed system for sensor applications will be introduced.
* Comprehend the architecture of Micro controllers
* Use facilities available in Micro Controllers
* Interface application circuits with Micro Controllers

**COURSE OUTCOMES:**

At the end of this course student should be able

1. Design interfacing circuits for input output to microcontrollers.
2. Operating ports and handling the devices connected to ports with use of ALP.
3. Embed the code in flash memory for stand-alone system for embedded system designs.
4. Designing PWM controls for power electronic circuits.
5. Interfacing ADC and DAC devices for digital applications with microcontrollers.

**UNIT-I: 8051 Microcontrollers**

Introduction to Intel 8 bit & 16 bit Microcontrollers, MCS-51 Architecture, Registers in MCS-51, 8051 Pin Description, 8051 Connections, 8051 Parallel I/O Ports, Memory Organization

Addressing Modes and Instructions-8051 Addressing Modes, MCS-51 Instruction Set, 8051 Instructions and Simple Programs, Using Stack Pointer, 8051 Assembly Language Programming, Development Systems and Tools, Software Simulators of 8051

**UNIT-II: MCS-51 Interrupts, Timer/Counters and Serial Communication**

Interrupts, Interrupts in MCS-51, Timers and Counters, Serial Communication, Atmel Microcontrollers (89CXX and 89C20XX), Architectural Overview of Atmel 89C51 and Atmel 89C2051, Pin Description of 89C51 and 89C2051, Using Flash Memory Devices Atmel 89CXX and 89C20XX

**UNIT-III: Applications of MCS-51 and ATMEL 89C51 and 89C2051 Microcontrollers**

Applications of MCS-51 and Atmel 89C51 and 89C2051 Microcontrollers- Square Wave Generation- Rectangular Waves- Pulse Generation- Pulse Width Modulation- Staircase Ramp Generation- Sine Wave Generation- Pulse Width Measurement- Frequency Counter

**UNIT- IV: PIC Microcontrollers**

PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)

**UNIT- V: PIC 16F8XX Flash Microcontrollers**

Introduction, Pin Diagram of 16F8XX, STATUS Register, OPTION\_REG Register, Power Control Register (PCON), PIC 16F8XX Program Memory, PIC 16F8XX Data Memory, DATA EEPROM and Flash Program EEPROM, Interrupts in 16F877, I/O Ports, Timers

**UNIT- VI: Interfacing and Microcontroller Applications**

Light Emitting Diodes (LEDs), Push Buttons, Relays and Latch Connections, Keyboard Interfacing, Interfacing 7-Segment Displays, LCD Interfacing, ADC AND DAC Interfacing with 89C51 Microcontrollers

**Industrial Applications of Microcontrollers -** Measurement Applications, Automation and Control Applications

**TEXT BOOK:**

1. Microcontrollers-Theory and Applications by Ajay V Desh mukh, McGraw Hills

**REFERENCE BOOKS:**

1. Microcontrollers by Kennith J ayala, Thomson publishers
2. Microprocessor and Microcontrollers by Prof C.R.Sarma

**WEB REFERENCES**

1. https://www.elprocus.com/microcontrollers-types-and-applications/

2. https://www.edgefxkits.com/blog/application-of-microcontroller-in-technology/

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| **I M.TECH****I SEMESTER****(Elective – II)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1PE08** | **REACTIVE POWER COMPENSATION & MANAGEMENT** |

**COURSE OBJECTIVES:**

* To know the basic objectives of reactive power compensation and the types of compensation methods
* To know the mathematical modelling of reactive power compensating devices.
* To know the reactive power compensation at distribution as well as transmission side.
* To know the role of reactive power compensation at electric traction systems and Arc furnaces.

**COURSE OUTCOMES:**

 After completion of the course the student will be able to

1. Acquire knowledge on various load compensations.
2. Develop the mathematical model of reactive power compensating devices
3. Analyze the Distribution Side and user Side Reactive Power management
4. Apply the concept of reactive power compensation in electrical traction & arc furnaces.

**UNIT -1: Load Compensation:**

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

**UNIT -2: Reactive Power Compensation in Transmission System:**

Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

**UNIT -3: Reactive Power Coordination:**

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

**UNIT -4: Distribution Side Reactive Power Management:**

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

**UNIT - 5: User Side Reactive Power Management:**

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

**UNIT-6: Reactive Power Management in Electric Traction Systems and Arc Furnaces:**

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

**TEXT BOOKS:**

1. T.J.E. Miller, Reactive power control in Electric power systems John Wiley and sons, 1982
2. D.M. Tagare, Reactive power Management Tata McGraw Hill, 2004

**WEB REFERENCES**

1. https://www.inspirenignite.com/jntuh/jntuh-m-tech-2017-2018-r17-detailed-syllabus-reactive-

 power- compensation-and-management-2/

2. https://www.accessscience.com/content/reactive-power-compensation-technologies/YB084380

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| **19MPI1PE09** | **SPECIAL MACHINES AND CONTROL** |

**COURSE OBJECTIVES**:

* The course enables students to:
* Know the concepts of Special type of electrical machines.
* Learn about the different sensors used in Brush less DC motors Draw the characteristics of special type electrical machines
* Understand the different control schemes for and PMSM
* Model the electrical machines with voltage, current, torque and speed equations.

**COURSE OUTCOMES:**

Upon completion of the course students are expected to:

1. Analyze the characteristics of different types of PM type Brushless DC motors and to design suitable controllers
2. Apply the knowledge of sensors used in PMSM which can be used for controllers and synchronous machines.
3. Evaluate the steady state and transient behavior linear induction motors
4. Analyze the different controllers used in electrical machines to propose the suitability of drives for different industrial applications
5. Classify the types of DC Linear motors and apply the knowledge of controllers to propose their applications in real world.

**UNIT I: Stepper Motors:**

Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor

**Characteristics of Stepper Motors**

Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

**UNIT II: Switched Reluctance Motors**

Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive Concept.

**UNIT III: Permanent Magnet Brushless DC Motors**

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessors based controller.

**UNIT IV: Permanent Magnet Synchronous Motors**

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power Controllers, Torque speed characteristics, Self-control, Vector control, Current control Schemes.

**UNIT V: Servomotors**

Servomotor – Types – Constructional features – Principle of Operation – Characteristics - Control – Microprocessor based applications.

**AC Tachometers** Schematic diagram, Operating principle, numerical problems.

**UNIT VI: Linear Motors**

Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

**TEXT BOOKS:**

1. Special Electrical Machines –K.Venkata ratnam-University Press.
2. Generalized Theory of Electrical Machines – P.S.Bimbra - Khanna Publications-5thEdition

**REFERENCE BOOKS:**

1. Miller, T.J.E.” Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenoj, T.” Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldela I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. Floyd E Saner , “ Servo Motor Applications”, Pittman USA, 1993.
5. Kenjo,T and Naganori, S “ Permanent Magnet and brushless DC Motors”, Clarendon Press, Oxford1989.

**WEB REFERENCES:**

1. http://eee.nitk.ac.in/course/special-machine-and-drives-ee366

2. https://nptel.ac.in/syllabus/108104011/

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| **I M.TECH****I SEMESTER****(Elective – II)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI1PE10** | **MODERN CONTROL THEORY** |

**COURSE OBJECTIVES:**

This course enables the students to:

* Understand some real systems, which use modern control theory.
* Analyze mathematical modelling of physical systems with the state space approach
* Estimate stability of non-linear systems with the help of modern control techniques
* Design modern controllers with the help of state space analysis
* Analyze and design optimal state feedback controllers

**Course Outcomes:**

Upon completion of the course students are expected to:

1. Develop the modelling of a real system using modern control theory
2. Apply modern engineering tools for modelling of physical system using state space

 approach

1. Analyze non-linear system stability using modern control techniques
2. Design modern controllers to meet the desired needs
3. Apply optimal control for designing state feedback controllers

**UNIT–I: Mathematical Preliminaries**

Fields, Vectors and Vector Spaces–Linear combinations and Bases–Linear Transformations and Matrices–Scalar Product and Norms–Eigen values, Eigen Vectors and a Canonical form representation of linear operators–The concept of state–State Equations for Dynamic systems–Time invariance and Linearity–Non uniqueness of state model–State diagrams for Continuous–Time state models.

**UNIT – II: State Variable Analysis**

Linear Continuous time model for physical systems–Existence and Uniqueness of Solutions to Continuous–Time State Equations–Solutions–Linear Time Invariant Continuous–Time State Equations–State transition matrix and it’s properties

**UNIT – III: Controllability and Observability**

General concept of Controllability-General concept of Observability Controllability tests for Continuous–Time Invariant systems-Observability tests for Continuous-Time Invariant systems-Controllability and Observability of state model in Jordan Canonical form-Controllability and Observability Canonical forms of State model

**UNIT – IV: Non Linear Systems–1**

Introduction–Non Linear Systems–Types of Non–Linearities–Saturation–Dead–Zone– acklash–Jump Phenomenon etc.; - Singular Points–Introduction to Linearization of nonlinear systems, properties of Non Linear Systems–Describing function–describing function analysis of nonlinear systems- Stability analysis of Non–Linear systems through describing functions

**Non Linear Systems – 11**

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

**UNIT – V: Stability Analysis**

Stability in the sense of Lyapunov, Lyapunov’s stability and Lyapunov’s instability theorems –Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method–Generation of Lyapunov functions–Variable gradient method–Krasooviski’s method.

**UNIT – VI: State Feedback Controllers and Observers**

State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order

**Optimal Control**

Introduction to optimal control – Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear quadratic regulator

**TEXT BOOKS:**

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997 Optimal control by Kirck

**REFFRENCE BOOKS:**

1. Control System Engineering- I.J.Nagarath, M. Gopal. New Age International Publications, 5thEdition.
2. Systems and Control- Stainslaw H.Zak, Oxford Press,2003.
3. Modern Control Systems- Richard C. Dorf and Robert H.Bishop,11thEdition Pearson Edu, India 2009.

**WEB REFERENCES:**

1. <https://www.sciencedirect.com/topics/engineering/modern-control-theory>

2. https://books.google.co.in/books/about/Modern\_control\_theory.html?id=qcefq7C4\_WEC

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| **I M.TECH****I SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **0** | **0** | **6** | **40** | **60** | **100** | **3** |
| **19MPI1LB01** | **POWER ELECTRONICS SYSTEM SIMULATION LAB** |

**COURSE OBJECTIVES:**

* To familiarize with characteristics of power electronic switches.
* To emphasize on usage of power electronics and electric drives in everyday life.

**COURSE OUTCOMES:**

Student will be able to

1. Analyse the characteristics of power electronic switches.
2. Develop switching pattern for the switches in a convertor.
3. Design convertor for machine and load specifications.
4. Apply various load phenomenon’s’ to analyse the converters.

**LIST OF EXPERIMENTS**

**Any Ten experiments from the following list are required to be conducted**

1. (a) Simulation of Single phase full convertor using R, RL, RL & E Load with and without

 Freewheeling Diode

 (b) Simulation of Single full convertor using R, RL, RL & E Load with and without LC

 Filter

1. (a) Simulation of three phase full Converter using R, RL Load

 (b) Simulation of three phase full Converter using RL Load with LC Filter.

1. (a)Simulation of Asymmetrical Pulse Width Modulation

 (b)Simulation of symmetrical Pulse Width Modulation

1. (a) Simulation of Single phase Voltage Source Invertor with Sinusoidal PWM controlfor

 R- Load

 (b) Simulation of Single phase Voltage Source Invertor with Sinusoidal PWM control for

 R- Load

1. (a) Simulation of three phase Voltage Source Invertor with Sinusoidal PWM controlfor R-

 Load

 (b) Simulation of three phase current Source Invertor with Sinusoidal PWM controlfor R-

 Load

1. (a)Simulation of Single phase AC Voltage controller with and without PWM controlfor

 RL- Load

(b)Simulation of three phase AC Voltage controller with and without PWM control for RL- Load

1. (a)Simulation of DC-DC Buck Converter

 (b)Simulation of DC-DC Boost Converter

 (c) Simulation of DC-DC Buck-Boost Converter

1. Simulation of Single phase symmetrical & Asymmetrical Cyclo – Converter with R – Load.
2. Cascade position control of DC motor drive (P, PI, PID controllers) using MATLAB/Simulink.
3. Simulation of DC motor with controlled AC rectification.
4. (a)Simulation of Capacitor – start Capacitor – run Single phase Induction motor using MATLAB/Simulink

 (b)Simulation of VSI fed Capacitor – start Capacitor – run Single phase Induction motor using MATLAB/Simulink

1. (a)Speed control of permanent Magnet Synchronous Motor using MATLAB/Simulink.

(b)Speed control of Brush Less DC Motor using MATLAB/ Simulink

(c)Speed control of Switched Reluctance Motor using MATLAB/ Simulink

**REFERENCE BOOKS:**

1. Fundamental of Power Electronics with MATLAB: Randall Sbaffer.
2. MATLAB and Simulink for Engineers Agam Kumar Tyagi
3. Modelling and Simulation Using MATLAB Simulink- Dr.Shallendra Jain.

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| **I M.TECH****II SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2TH01** | **CONTROL OF DC & AC DRIVES** |

**COURSE OBJECTIVES:**

* To review the fundamentals of DC Machines
* To Study and analysis, the operation of converter/chopper fed DC Drive both qualitatively and quantitatively.
* To familiarize the students on the operation of VSI and CSI fed induction motor drive.
* To impart knowledge on synchronous motor drives.

**COURSE OUTCOMES:**

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

1. Identify the basics of DC Machine.
2. Analyze power supplies for DC Machines Loads.
3. Acquire the knowledge on Chopper controlled DC Drives.
4. Identify the basics of AC Machines
5. Acquire knowledge on the operation of CSI and VSI fed Induction Motor drives
6. Formulate the control schemes for Synchronous Motor Drives.

**Unit-I: DC Machines**

Elementary dc machines and Analysis of Steady State operation- voltage and torque equations-dynamic Characteristics of permanent magnet and shunt dc motors-Time domain block diagrams -solution of dynamic characteristics by Laplace Transformation-Digital computer simulation of permanent magnet and shunt dc machines

**Unit-II: Rectifier Control of dc drives**

Principle of phase control -fundamental relations, Analysis of series and Separately exited DC motor with single -phase and three-phase Converters -Waveforms- performance Parameters-performance characteristics. continuous and discontinuous armature current Operation-Current ripple and its effect on performance -operation with freewheeling diode -implantation of braking schemes-Drive employing dual converter.

**Unit-III: Chopper Control of Dc Drives**

Interdiction to Time ratio Control and frequency modulation -classA,B,C,Dand E chopper controlled DC motor -Performance analysis-Multi quadrant control-chopper based implementation of Braking schemes, Multi phase chopper, related problems..

**Unit-IV: Induction Machines**

Basics of induction motors-classification-equivalent circuit-torque vs slip characteristics- steady state performance-Dynamic modelling of induction motor – three phases to two phase transformation- stator-rotor and synchronously rotating reference frame model.

**Unit-V: VSI and CSI fed Induction Motor Drives**

AC Voltage controller circuit-six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed variable frequency drives-comparison.

**Unit-VI Synchronous Motor Drives**

Wound field cylindrical rotor motor-Equivalent circuits-performance equations for operation from a voltage source- starting and braking- V curves-self-control-margin angle control-torque control-power factor-brushless excitation systems.

**TEXT BOOKS:**

1. Gopal K Dubey, “power semiconductor control drives”, prentice Hall Inc, New jersy m,1989
2. Bimal k Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia 2002.

**REFERENCE BOOKS:**

1. Gopal K Dubey,” Fundamentals of Electric Drives”. Narosa Publishing House, New Delhi second Edition 2009
2. P.C.Sen, : Thyristor DC Drives “, John Wiely and sons, New York 1981.
3. R.Krishnanan,” Electric Motor drives -Modelling, Analysis control “, Pentice Hall of India PVT.LTD, New Delhi ,2010.
4. Vedam Subramanayam, “Electric drives-concepts and applications”, Tata McGraw Hall publishing company Ltd, New Delhi 2002.

**WEB RESOURCES:**

1. https://www.youtube.com/watch?v=9h2lEIpo74A
2. https://www.youtube.com/watch?v=96hvtQ8Qlvo

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| **I M.TECH****II SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2TH02** | **SOFT COMPUTING TECHNIQUES** |

**COURSE OBJECTIVES:**

The main objective of the course is to:

* Know Soft Computing basics and its branches
* Understand the basic implementation details on Artificial Neural Networks
* Understand fuzzy logic and it application in ANN.
* Able to understand the Fuzzy logic operators and classical control systems
* Introduction of Genetic Algorithms and its application
* Elaborate discussion on applications of Soft Computing

**COURSE OUTCOMES**:

1. Distinguish between Soft Computing and Hard computing.
2. Define the branches Artificial Neural Networks, Fuzzy Logic, and Support Vector

 machine

1. Analyze concepts of Fuzzy Logics & Classical Sets
2. Analyze the concepts of Fuzzy operators and Classical Logic controls
3. Analyze the concepts of Genetic Algorithms
4. Evaluate the complexity by using various soft computing methods

**UNIT-I: Basic Elements of Soft Computing**

Introduction to soft computing, Fuzzy logic, Neural Networks and Evolutionary Computing, Approximations of Multivariate functions, Non – linear Error surface and optimization. Artificial Neural Networks- Introduction, Basic models of ANN, important terminologies, Basic Learning Laws, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Back propagation Network. Radial basis function network and Hopfield Networks

**UNIT-II: Unsupervised Learning Network**

Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks. Special Networks-Introduction to various networks.

**UNIT-III: Introduction to Classical Sets and Fuzzy Sets**

Crisp Sets and Fuzzy Sets- operations. Classical Relations and Fuzzy Relations- Cardinality, Properties and composition. Tolerance and equivalence relations. Membership functions- Features, Fuzzification, membership value assignments, Defuzzification.

**UNIT-IV: Fuzzy Logic**

Classical& Fuzzy logic, Operations, Boolean Logic, Multivalued Logics, Fuzzy Rule Base and Approximate Reasoning ,Fuzzy Decision making ,Fuzzy Logic Control Systems.

**UNIT-V: Genetic Algorithm**

Introduction, Traditional Optimization and search techniques, Search space, Operators: Encoding, Selection, Crossover and Mutation. Stopping Condition of GA.

**UNIT VI: Support Vector Machine**

Introduction, optimal hyper plane for linearly separable pattern, linear classifier, nonlinear classifier problem, optimal plane for non-separable pattern, example XOR problem, support vector machine for non-linear regression, summary and discussion.

Applications of Soft Computing - A fusion Approach of Multispectral Images with SAR Image for flood area analysis, Optimization of TSP using GA Approach and GA-Fuzzy system for Control of flexible Robots

**TEXT BOOK:**

1. Principles of Soft Computing- S N Sivanandam, S N Deepa, Wiley India, 2011 2. V. Kecman, “Learning and Soft computing”, Pearson Education, India

**REFERENCE BOOKS:**

1. Soft Computing and Intelligent System Design -Fakhreddine O Karray, Clarence D Silva,. Pearson Edition, 2004.
2. Introduction to Fuzzy Systems, Guanrong Chen, Trung Tat Pham, Chapman & Hall/CRC, 2009.
3. S. Haykins,“Neural networks: a comprehensive foundation”. Pearson Education, India.

**WEB RESOURCES:**

1. https://www.sciencedirect.com/science/article/pii/S1877050916325467

2. http://shodhganga.inflibnet.ac.in/bitstream/10603/11748/9/09\_chapter\_03.pdf

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| **I M.TECH****II SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2TH03** | **POWER ELECTRONICS IN RENEWABLE ENERGY SYSTEMS** |

**COURSE OBJECTIVES:**

* To illustrate the operation of modern power semiconductor devices
* To analyse the performance of converters used for various conversion systems
* To design PV system, wind energy system and controller for power converters
* To apply appropriate controlling technique and converters for applications of various Renewable energy systems

**COURSE OUTCOMES**:

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

1. Explain the operation of modern power semiconductor devices
2. Analyse the performance of converters used for various conversion systems
3. Design PV system, wind energy system and controller for power converters
4. Apply appropriate controlling technique and converters for applications of various Renewable energy systems

**UNIT I: Modern Power Semiconductor Devices**

Modern power semiconductor devices – MOS turn Off Thyristor (MTO) – Emitter Turn off Thyristor (ETO) – Integrated Gate Commutated thyristor (IGCTs) – MOS controlled thyristors (MCTs) – Static Induction circuit – comparison of their features.

**UNIT II: Power Converters for Solar Applications**

Solar: Characteristics of sunlight- semiconductors and P-N junctions-behaviour of solar cells- cell properties- PV cell interconnection- block diagram of solar photo voltaic system. Principle of operation: line commutated converters (inversion-mode)- boost and buck-boost converters- Selection of inverter-Multilevel inverters and its types- Battery sizing and array sizing.

**UNIT III: Photo Voltaic Power Systems**

Types of PV Systems: Stand-alone PV system: Charge controllers - series, shunt charge regulators and DC/DC converters- maximum power point tracking- selection of inverters- solar pumping application. Grid Connected PV Systems: Inverter types – Line, self-commutated inverters and PV inverter with high frequency transformer- grid-compatible inverter characteristics

**UNIT IV: Electrical Machines and Power Converters for Wind Applications**

Wind: Basic principle of wind energy conversion- nature of wind- power in the wind- components of Wind Energy Conversion System (WECS)- performance of induction generators for WECS- classification of WECS. Electrical Machines: Principle of operation and analysis of induction generator- permanent magnet synchronous generator- squirrel cage induction generator and doubly fed induction generator. Power converters: Three phase AC voltage controllers- AC/DC/AC converters - uncontrolled rectifiers- PWM inverters- grid interactive inverters and matrix converters.

**UNIT V: Wind Power Systems**

Types of wind power systems, stand-alone WECS: Elements of a stand-alone WECS- battery charging application with block diagram. Grid connected WECS: Soft starting technique of induction generator- control of wind turbines- fixed and variable speed wind turbines-Selection of generators for variable speed wind turbines - Synchronous generator- squirrel cage and wound rotor induction generator-Isolated grid supply system with multiple wind turbines.

**UNIT VI: Hybrid Energy Systems**

Need for hybrid energy systems- issues in designing the hybrid energy systems- PV and Diesel hybrid system: Types – Series, parallel and switched hybrid energy systems- Stand-alone PV and wind hybrid energy system-Hybrid wind and diesel energy systems.

**TEXT BOOKS**

1. Rashid. M. H, Power electronics Hand book, Academic press, 2001.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons – Second Edition
3. Mukund R Patel, Wind and Solar Power Systems, CRC Press, 2004.

**REFERENCE BOOKS**

1. J K Kaldellis, Stand-alone and Hybrid Wind Energy Systems: Technology, Energy Storage and Applications, Woodhead Publishing, 2010.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 2002.

**WEB RESOURCES**

1. https://www.youtube.com/watch?v=8lrqaWyCAbA
2. https://www.youtube.com/watch?v=khzMZ8VL8Q4&list=PLuv3GM6-gsE2KyXoBTQ6lbrwn22Z3SiVm
3. https://www.youtube.com/watch?v=C\_1bxQPtoT0
4. https://www.youtube.com/watch?v=GExTwRNkQBg
5. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLCBKiW2ShR0B5Rs-ytbbp-uyiPAzqdZts

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| **I M.TECH****II SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **4** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2TH04** | **POWER SYSTEM DEREGULATION** |

**COURSE OBJECTIVES:**

* To provide in-depth understanding of operation of deregulated electricity market systems.
* To impart the knowledge on fundamental concepts of congestion management.
* To analyze the concepts of location marginal pricing and financial transmission rights.
* To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

**COURSE OUTCOMES:**

After Completion of this course students will be able to

1. Explain the operation of deregulated electricity market systems
2. Examine the cost-effective methods to supply quality power
3. Analyze price based unit commitment problems
4. Evaluate the transmission costing and congestion management methods
5. Analyze various operational and control issues of electricity market

**UNIT-I: Generation System Reliability Analysis**

Load forecasting and system reliability – load Forecasting – Generation system reliability – Co-ordination methods – economic operation of power systems – Simple problems.

**UNIT-II; Overview of Key Issues in Electric Utilities**

Introduction –Restructuring models –Independent system operator (ISO) –Power Exchange -Market operations –Market Power –Standard cost –Transmission Pricing –congestion Pricing –Management of Inter zonal/Intra zonal Congestion.

**UNIT-III: OASIS: Open Accesses Same-Time Information System**

Structure of OASIS -Pulsing of Information –Transfer capability on OASIS –Definitions Transfer Capability Issues –ATC –TTC –TRM –CBM calculations –Methodologies to calculate ATC

**UNIT-IV: Electricity Pricing**

Introduction –electricity Price Volatility Electricity Price Indexes –challenges to Electricity Pricing –Construction of Forward Price Curves –Short-time Price Forecasting.

**UNIT-V: Power System Operation in a Competitive Environment**

Introduction –Operational Planning Activities of ISO-The ISO in Pool Markets –The ISO in Bilateral Markets –Operational Planning Activities of a Genco

**UNIT-VI: Ancillary Services Management**

Introduction –Reactive Power as an Ancillary Service –a review –Synchronous Generators as Ancillary Service Providers.

**TEXT BOOKS:**

1. Kankar Bhattacharya, Math H.J. Boller, JaapE. Daalder, ―Operation of Restructured Power System‖ Klum, er Academic Publisher –2001.
2. AshikurBhuiya: Power System Deregulation: Loss Sharing in Bilateral Contracts and Generator Profit Maximization, Publisher VDM Verlag, 2008.

**REFFERENCE BOOKS:**

1. Mohammad Shahidehpour, and Muwaffaqalomoush,-―Restructured Electrical Power systems‖ Marcel Dekker, Inc. 2001.
2. Loi Lei Lai; ―Power system Restructuring and Deregulation‖, Jhon Wiley & Sons Ltd., England.

**WEB REFERENCES:**

1. https://nptel.ac.in/courses/108101040/Module%207/L01-Introduction%20to%20Deregulation-

 pdf

2. https://shodhganga.inflibnet.ac.in/bitstream/10603/17295/13/13\_chapter3.pdf

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| **I M.TECH****II SEMESTER****(Elective – III)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE04** | **SMART GRID** |

**COURSE OBJECTIVES**:

* To understand the Smart grid initiatives and technologies
* To understand the Information and communication technologies for the smart grid
* To understand the Sensing, measurement, control and automation.
* To understand the main issues of smart grid development and critical technologies.
* To understand the development, and technological potentials in this area.
* To understand the Power Quality Management in Smart Grid

**Course Outcomes**:

On successful completion of the course, student will be able to demonstrate knowledge in:

1. Demonstrate knowledge in Smart grid initiatives and technologies
2. Explain Information and communication technologies for the smart grid Sensing,

measurement, control and automation.

1. Apply skills in fault calculation and state estimation.
2. Apply various information security tools in the smart grid technology.
3. Demonstrate the power quality issues of grid connected renewable energy sources and

 Power quality conditioners for smart grid

**UNIT–I: Smart Grid**

Introduction, Ageing assets and lack of circuit capacity, thermal constraints, operational constraints, security of supply, national initiatives, early smart grid initiatives, active distribution networks, virtual power plant, other initiatives and demonstrations, overview of the technologies required for the smart grid.

**UNIT–II: Communication Technologies for the Smart Grid**

**Data Communications:** Introduction, Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Wired Communication, Optical Fiber, Radio Communication, Cellular Mobile Communication, Layered Architecture and Protocols, the ISO/OSI Model, TCP/IP

**Communication Technologies:** IEEE 802 Series, Mobile Communications, Multi-Protocol Label Switching, Power line Communication, Standards for Information Exchange, Standards for Smart Metering, Modbus, DNP3 and IEC61850

**UNIT–III: Information Security for the Smart Grid**

Introduction, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption, Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest, Cyber Security Standards, IEEE 1686: IEEE Standard for Substation Intelligent Electronic Devices(IEDs) Cyber Security Capabilities, IEC 62351: Power Systems Management and Association Information Exchange – Data and Communication Security.

**UNIT–IV: Smart Metering and Demand Side Integration**

Introduction, smart metering – evolution of electricity metering, key components of smart metering, smart meters: an overview of the hardware used – signal acquisition, signal conditioning, analogue to digital conversion, computation, input/output and communication.

Communication infrastructure and protocols for smart metering - Home area network, Neighborhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side, System Support from DSI.

**UNIT–V: Transmission and Distribution Management Systems**

Data Sources, Energy Management System, Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modelling and Analysis Tools, Distribution System Modelling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Energy Storage Technologies, Batteries, Flow Battery, Fuel Cell and Hydrogen Electro lyser, Flywheels, Super conducting Magnetic Energy Storage Systems, Super capacitors.

**UNIT – VI: Power Quality Management in Smart Grid**

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. Information and Communication Technology for Smart Grid-Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbour hood

Area Network (NAN), Wide Area Network (WAN).

**TEXT BOOKS:**

1. Janaka Ekanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, Smart Grid,Wiley Publications, 2012.
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley,IEEE Press, 2012.
3. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and DemandResponse” CRC Press

**REFERENCE BOOKS:**

1. Raj Samani, Applied Cyber Security and the Smart Grid, SyngressPublishers, 2012.
2. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Futureof Electric Utilities”, Island Press; 1st edition 8 Jun 2010
3. S.Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active DistributionNetworks.” Institution of Engineering and Technology, 30 Jun 2009

**WEB REFERENCES:**

1. https://www.smartgrid.gov/the\_smart\_grid/smart\_grid.html

2. https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-

 grid

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| **I M.TECH****II SEMESTER****(Elective – III)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE05** | **POWER QUALITY** |

**COURSE OBJECTIVES**:

* Able to understand the fundamentals of power quality problems.
* Able to understand the various causes which create the distortion in the power supply.
* Able to understand the mitigation and power quality standards.
* Able to know about an introduction to power quality measurement devices.
* Able to know about power quality issues in distributed generation.

**COURSE OUTCOMES:**

After completion of the course, students will be able to

1. Demonstrate the power quality problem in power system.
2. Analyze the harmonic distortion due to commercial and industrial loads.
3. Identify suitable device for power quality measurements.
4. Explain the mitigation techniques for power quality issues.
5. Apply skills in design of various custom power devices.
6. Apply the principles of interfacing distributed generation with utilities.

**UNIT-I: Fundamentals of Power Quality**

Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage and Outage. Sources and causes of different Power Quality Disturbances.

**UNIT-II: Harmonics and Applied Harmonics**

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non-Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics**:** Effects of Harmonics, harmonic distortion evaluations, principles of controlling harmonics and devices for controlling harmonic distortion.

**UNIT-III: Voltage Regulation using Conventional Methods**

Principles of regulating the voltage, Devices for voltage regulation: utility step voltage regulators, ferro-resonant transformers, magnetic synthesizers, on-line UPS systems, motor-generator sets, static VAR compensators, shunt capacitors and series capacitors.

**UNIT-IV: Power Quality Enhancement using Custom Power Devices**

Introduction to Custom Power Devices - Network Reconfiguring Type: Solid State Current Limiter (SSCL) - Solid State Breaker (SSB) – Solid State Transfer Switch (SSTS).

Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner – operation, realization and control of DVR, DSTATCOM and UPQC – load compensation. Power quality monitoring – Power quality monitoring standards.

**UNIT-V: Power Quality issues In Distributed Generation**

DG Technologies, Perspectives on DG benefits - Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

**UNIT-VI: Application of Custom Power Devices in Power Systems**

P-Q theory –Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control – Unified Power Quality Conditioner (UPQC) – Operation and control. Recent custom power devices.

**TEXT BOOKS:**

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. WayneBeaty, Electrical Power Systems Quality, 2nd edition, TATA McGraw Hill,2010.
2. ArindamGhosh, Gerard Ledwich, Power Quality Enhancement Using CustomPower Devices, Springer, 2002.

**REFERENCE BOOKS:**

1. Math H J Bollen, “Understanding Power Quality Problems” IEEE Press, 1998.
2. C.Sankaran, Power Quality, CRC press, 2000.

**WEB REFERENCES:**

**1.** https://www.captech.com.au/what-is-power-quality/

**2.** https://www.cet.edu.in/noticefiles/227\_Electrical\_Power\_Quality-PEEL5403-8th\_Sem-

 Electrical.pdf

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| **I M.TECH****II SEMESTER****(Elective – III)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE06** | **POWER SYSTEM STABILITY** |

**COURSE OBJECTIVES:**

* To impart the fundamental concepts of stability of power systems and its classification.
* To expose the students to dynamic behaviour of the power system for small and large disturbances.
* To understand and enhance the stability of power systems.

**COURSE OUTCOMES:**

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

1. Acquire the knowledge about the stability of power system
2. Acquire the knowledge on small-signal stability, transient stability and voltage stability.
3. Explain the dynamic behaviour of synchronous generator for different disturbances.
4. Analyze the various methods to enhance the stability of a power system

**UNIT-I: Introduction to Stability**

Fundamental concepts-Stability and energy of a system-Power System Stability-Definition-Causes-Nature and Effects of disturbances-Classification of stability-modelling of electrical components-Basic assumptions made in stability studies.

**UNIT-II: Synchronous Machine Modeling**

Modelling of Synchronous machine for stability studies (classical model)-Rotor dynamics and the swing equation-Equivalent circuits of synchronous machine-Flux linkage state space model- Treatment of saturation Synchronous machine connected to infinite bus-Current-Voltage and flux linkage models.

**UNIT–III: Small-Signal Stability**

Basic concepts and definitions-State space representation-Physical Interpretation of small-signal stability-Eigen properties of the state matrix-Eigenvalues and eigenvectors-modal matrices- eigenvalue and stability-mode shape and participation factor-Small signal stability analysis of a Single-Machine Infinite Bus (SMIB) Configuration with numerical example.

**UNIT–IV: Transient Stability**

Review of numerical integration methods-modified Euler and Fourth Order Runge-Kutta methods-Numerical stability-Interfacing of Synchronous machine (classical machine) model to the transient stability algorithm (TSA) with partitioned-explicit approaches-Application of TSA to SMIB system.

**UNIT-V: Voltage Stability**

Factors affecting voltage stability-Classification of Voltage Stability-Transmission system characteristics-Generator characteristics-Load characteristics- Characteristics of reactive power compensating Devices-Voltage collapse-Reactive power-voltage control-‘P-V’ curves and‘Q-V’ curves-Power Flow analysis for voltage stability-Voltage critical and angle critical for a two bus system.

**UNIT-VI: Enhancement of Small-Signal Stability and Transient Stability**

Power System Stabilizer-Principle behind transient stability enhancement methods-high speed fault clearing regulated shunt compensation-dynamic braking-reactor switching-independent pole-operation of circuit-breakers-single-pole switching-fast valving-high speed excitation systems.

**TEXT BOOKS:**

* + - 1. Power system stability and control, P. Kundur ; edited by Neal J. Balu, Mark G. Lauby,

McGraw-Hill, 1994.

1. R. Ramnujam,” Power System Dynamics Analysis and Simulation, PHI Learning Private

Limited, New Delhi, 2009

1. T.V. Cutsem and C.Vournas, “Voltage Stability of Electric Power Systems”, Kluwer

publishers, 1998.

**Reference Books:**

* + - 1. Peter W., Saucer, Pai M.A., “Power System Dynamics and Stability, Pearson Education

(Singapore), 9th Edition, 2007.

* + - 1. EW. Kimbark., “Power System Stability”, John Wiley & Sons Limited, New Jersey, 2013.
1. SB. Crary., “Power System Stability”, John Wiley & Sons Limited, New Jersey, 1955.
	* + 1. K.N. Shubhanga,“Power System Analysis” Pearson, 2017.
			2. Power systems dynamics: Stability and control / K.R. Padiyar, BS Publications, 2008.

**WEB REFERENCES:**

https://www2.theiet.org/resources/books/pow-en/powersys.cfm

https://nptel.ac.in/courses/108106026/5+&cd=1&hl=en&ct=clnk&gl=in

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| **I M.TECH****II SEMESTER****(Elective – IV)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE07** | **CUSTOM POWER DEVICES** |

**COURSE OBJECTIVES:**

* Understand power quality and general classes of power quality problems
* Understanding and analyzing voltage disturbances
* Analyze the different types of harmonic problems.
* Understand the concept of Harmonic Compensation Devices
* Understand the Application of Custom Power Devices
* Understand the concept Distributed Generation Technologies

**COURSE OUTCOMES**:

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

1. Define the power quality problems
2. List the different methods to mitigate the power quality issues
3. Identify the different voltage regulating devices for the Voltage changes
4. Identify the Harmonic Compensation Devices
5. Define the DG Technologies
6. Identify the Application of Custom Power Devices

**UNIT- I: Introduction**

Custom Power and Custom Power Devices - power quality variations in distribution circuits –Voltage Sags, Swells, and Interruptions - System Faults – Over voltages and Under voltages - Voltage Flicker - Harmonic Distortion - Voltage Notching – Transient Disturbances - Characteristics of Voltage Sags.

**UNIT-II: Overview of Custom Power Devices**

Reactive Power and Harmonic Compensation Devices - Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices – Battery UPS – Super Conducting Magnetic Energy Storage systems – Flywheel– Voltage Source Converter - Multi-level converters

**UNIT-III: Reactive Power and Harmonic Compensation Devices**

Var control devices - Static Var Compensator – Topologies - Direct Connected Static Var Compensation for Distribution Systems – Static Series Compensator - Static Shunt Compensator (DSTATCOM) – Interaction with Distribution Equipment and System - Installation Considerations.

**UNIT- IV: High-Speed Source Transfer Switches, Solid State Limiting, and Breaking Devices**

Source Transfer Switch - Static Source Transfer Switch (SSTS),- Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker.

**UNIT-V: Application of Custom Power Devices in Power Systems**

P-Q theory –Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control– Unified Power Quality Conditioner (UPQC) – Operation and control. Recent custom power devices.

**UNIT-VI: Distributed Generation and Power Quality**

Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

**TEXT BOOKS:**

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
2. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002.

**REFERENCES BOOKS:**

1. Power Quality, C. Shankaran, CRC Press, 2001.
2. Instantaneous power theory and application to power conditioning, H. Akagi et.al., IEEE Press, 2007
3. Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002.
4. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008.POWERCON 2008.

**WEB REFERENCES:**

1. https://link.springer.com/chapter/10.1007/978-1-4615-1153-3\_4

2. https://www.researchgate.net/publication/50315846\_Role\_of\_custom\_power\_devices\_in\_Power

 \_Quality\_ Enhancement\_A\_Review

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| **I M.TECH****II SEMESTER****(Elective – IV)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE08** | **DIGITAL CONTROL SYSTEMS** |

**COURSE OBJECTIVES:**

This course enables the students to:

* Understand the principles of various types of digital control systems in daily life.
* Learn the basic knowledge of A/D and D/A conversion.
* Understand the basics of Z-Transform.
* Study the stability analysis of digital control system.
* Know about the design of digital control system for different engineering applications.

**COURSE OUTCOMES:**

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

1. Design the models of dynamic systems and obtain pulse transfer functions used in real

 time control applications.

1. Analyze stability of linear time-invariant systems along with their properties and

 characteristics.

1. Design a controller based on time domain and frequency domain approaches.
2. Analyze the stability of a system using bilinear transformation, Jury’s stability and

 Liapunov theorems.

1. Design the digital PID Controller and discrete data control systems.

**UNIT- I: Sampling and Reconstruction**

Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal. Z –TRANSFORMS: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z –transforms, Modified Z- Transforms.

**UNIT-II: Z-Plane Analysis of Discrete-Time Control System**

Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.

**UNIT-III: State Space Analysis**

State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it’s Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations

**UNIT-IV: Controllability and Observability**

Concepts of Controllability and Observability, Tests for Controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function

**UNIT-V: Stability Analysis**

Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems.

**UNIT-VI: State Feedback Controllers and Observers**

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman’s formula. State Observers – Full order and Reduced order observers.

**Linear Quadratic Regulators**

Min/Max principle, Linear Quadratic Regulators, Kalman filters, State estimation through Kalman filters, introduction to adaptive controls.

**TEXT BOOKS:**

1. K. Ogata, “Discrete Time Control systems”, 2nd edition, Pearson, Edition, 2010.
2. M. Gopal, “Digital Control and State Variable Methods”, 1st edition, TMH, 2010.

**REFERENCE BOOKS:**

1. Kuo, “Digital Control Systems”,. 2ndedition, Oxford University Press,2003.
2. M. Gopal, “Digital Control Engineering”, 1st edition, TMH publisher,2008.

**WEB REFERNCES:**

1. https://nptel.ac.in/courses/108103008/

2. https://www.sciencedirect.com/topics/engineering/digital-control-system

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| **I M.TECH****II SEMESTER****(Elective – IV)** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **3** | **0** | **0** | **40** | **60** | **100** | **3** |
| **19MPI2PE09** | **HIGH VOLTAGE DC TRANSMISSION** |

**COURSE OBJECTIVES:**

* + - * To analyze state of the art of HVDC technology and converter operation for two and multi- terminal DC systems
			* To acquire knowledge about methods of HVDC converter control
			* To impart the concept of AC-DC system interactions and protection scheme in HVDC system

**COURSE OUTCOMES:**

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

1. Analyze the operation of power converters.
2. Define the control principles of HVDC converters and analyze the harmonics of

 converters.

1. Evaluate the importance of MTDC systems.
2. Apply the Modeling of HVDC system and analysis of converter faults, protection, AC-DC

 interactions.

**UNIT- I Introduction:**

HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration-Line commutated converters, Voltage source converters

**UNIT-II Static Power Converters:**

3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers- Analysis of Voltage source converters

**UNIT-III Harmonics and control of HVDC systems:**

Harmonics in HVDC Systems, Harmonic elimination- AC and DC filters, Filter design.Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control.

**UNIT- IV MTDC systems:**

Multi-terminal DC links and systems; Types of MTDC systems, Control and Protection of MTDC Systems Study of MTDC Systems, Multi in-feed DC Systems, MTDC using VSC.

**UNIT- V Converter faults protection and modelling:**

Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, DC circuit breakers. Over voltage protection of converters, surge arresters.

**UNIT- VI Modelling and analysis of AC-DC system interactions**:

Component models for the analysis of AC/DC systems -Introduction, System Models, General Converter Models, Model of Converter Controller, Modelling of a DC Network, Modelling of AC Network, Power flow analysis of AC/DC systems, interaction of AC/DC systems

**TEXT BOOKS:**

* + - 1. S.Kamakshaiah, V.Kamaraju,’ HVDC Transmission’, Tata McGraw-Hill Education Pvt. Ltd., 2011.
			2. K. R. Padiyar, “HVDC Power Transmission Systems”, Wiley Eastern Ltd., 1990.

**REFERENCES:**

1. E. W. Kimbark, “Direct Current Transmission”, Vol. I, Wiley Inderscience, 1971.
2. Erich Uhlmann, “Power Transmission by Direct Current”, B.S. Publications, 2004.
3. Arrillaga, “High Voltage Direct Transmission”, Peter Peregrinus Ltd. London, 1983

**WEB REFERENCES:**

* + - 1. URL: https://nptel.ac.in/courses/108104013/
			2. URL : https://nptel.ac.in/courses/108101040/22

**E-BOOKS:**

https://grieteee1317.files.wordpress.com/2016/11/hvdc-kundur-textbook.pdf

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| **I M.TECH****II SEMESTER** | **L** | **T** | **P** | **INTERNAL****MARKS** | **EXTERNAL****MARKS** | **TOTAL****MARKS** | **CREDITS** |
| **0** | **0** | **6** | **40** | **60** | **100** | **3** |
| **19MPI2LB01** | **POWER CONVERTERS LAB** |

**COURSE OBJECTIVES:**

* To provide hands- on- experience on various Power Electronic converters.
* To expose students to various motion control schemes of electric machines.

**COURSE OUTCOMES:**

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

1. Determine the various parameters of three phase converters and provide

 valid conclusions on the performance of these different power converters

1. Select suitable DC drive for specific application
2. Analyze the various causes of harmonic and design a PWM converter
3. Design converter fed dc drives and chopper fed dc drives

**LIST OF THE EXPERIMENTS:**

**Any 10 of the following experiments to be conducted:**

1. 3-Փ AC Voltage Controller on motor Load.
2. 3-Փ Full Converter with R & RL Loads.
3. 3-Փ Full Converter with DC motor Drive.
4. Four quadrant chopper drive using DC Motor.
5. 1-Փ IGBT based PWM Inverter on R & RL Loads
6. 3-Փ IGBT based PWM Inverter on R & RL Loads
7. 3-Փ SCR based Inverter Drive for AC Motor Module
8. Speed Controller of 3- Փ slip- ring Induction Motor by Static Rotor Resistance Controller
9. 3-Փ PWM Pulse Generator Module
10. DSP Based V/F Control of Induction Motor
11. 3-Փ PWM Pulse Generation using FPGA
12. FPGA based 3-Փ IGBT inverter.