# ACADEMIC REGULATIONS COURSE STRUCTURE AND DETAILED SYLLABUS

# M.Tech

## DIGITAL ELECTRONICS AND COMMUNICATION ENGINEERING (DECE)

**(APPLICABLE FOR THE BATCHES ADMITTED FROM 2018-2019)**

**Department of Electronics & Communication Engineering**

**G. Narayanamma Institute of Technology & Science (for Women)**
**(Autonomous)**
**Shaikpet, Hyderabad - 500 104, Telangana State**

# G. NARAYANAMMA INSTITUTE OF TECHNOLOGY & SCIENCE (For Women) (AUTONOMOUS)

**Shaikpet, Hyderabad– 500104**

## ACADEMIC REGULATIONS 2018

**for CBCS Based M.Tech. Degree Course (Regular/Full Time PG Programme)**

(Effective for the students admitted into I year from the Academic Year **2018-19** and onwards)

**1.0 Post-Graduate Degree Course (PGDC) in Engineering & Technology (E & T)**

G. Narayanamma Institute of Technology & Science (GNITS) - for Women, Hyderabad, affiliated to Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, offers 2 Year (4 Semesters) Master of Technology (M. Tech.) Degree Course under Choice Based Credit System (CBCS), with effect from the Academic Year 2018 - 19 onwards in the following Branches of Engineering & Technology with the Specializations as listed below :

| ***S.No.*** | ***Branch/ Department*** | ***Specialization*** |
|---|---|---|
| I. | Computer Science & Engineering | Computer Science & Engineering |
| II. | Electrical & Electronics Engineering | Power Electronics & Electric Drives |
| III. | Electronics & Communication Engineering | Digital Electronics & Communication Engineering |
| IV. | Electronics & Telematics Engineering | Wireless & Mobile Communications |
| V. | Information Technology | Computer Networks & Information Security |

**2.0 Eligibility for Admission**

**2.1** Admission to the **PGDC** shall be made either on the basis of - the Rank/Percentile earned by the candidate in the relevant qualifying GATE Examination, OR the Merit Rank obtained by the qualifying candidate at an Entrance Test conducted by the Telangana State Government (PGECET) for M.Tech. Programmes, OR an Entrance Test conducted by the Jawaharlal Nehru Technological University Hyderabad, OR on the basis of any other order of merit approved by the University, subject to the reservations as prescribed by the Government from time to time.

**2.2** The medium of instruction for all the PG Programmes shall be ENGLISH only.

**3.0 M.Tech. Degree Course Structure**

**3.1** All M.Tech. Programmes at GNITS are of the Semester Pattern with 4 Semesters constituting 2 Academic Years, and each Academic Year has TWO Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 Weeks duration (inclusive of Examinations) with a minimum of 90 Instructional Days per Semester.

**3.2** UGC/ AICTE specified Definitions/ Descriptions are adopted appropriately for the various terms and abbreviations used in this PGDC - Academic Regulations/Norms.

### 3.2.1 Semester Scheme:

Each M.Tech Degree Course is of 2 Academic Years (4 Semesters) with each academic year divided into two Semesters of ~ 22 weeks ( ≥ 90 working days) each, and each semester has - 'Continuous Internal Evaluation' (CIE) and 'End Semester Examination' or 'Semester End Examination' (SEE). Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as denoted and suggested by UGC and AICTE are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' or 'COURSE' imply the same meaning here, and refer to 'Theory Subject', or 'Lab/Practical Course', or 'Design/ Drawing Subject', or 'Elective (Program Specific Elective/ Open Elective)', or 'Mini-Project with Seminar', or 'Project', or 'Audit Course' as the case may be.

### 3.2.2 Credit Courses:

All the Subjects/Courses are to be registered by a student in a semester to earn Credits. Credits shall be assigned to each Subject/ Course in a **L: T: P: C** (**L**ecture Periods: **T**utorial Periods: **P**racticals Periods : **C**redits) Structure, based on the following general pattern:

- One Credit - for One hour/ Week/ Semester for Theory/ Lecture (L) Courses, and Tutorials (T); and,
- One Credit - for Two hours/ Week/ Semester for Laboratory/ Practical (P) Courses.
- Student activity courses like NCC, NSS, NSO, and other Courses identified as Audit Courses shall not carry Credits.

### 3.2.3 Subject/ Course Classification :

All Subjects/ Courses offered for the PGDC are broadly classified as:

(a) Core Courses (CoC), and
(b) Elective Courses (Elc)

- Core Courses (CoC) and Elective Courses (Elc) are categorized as PS (Professional Subjects), which are further subdivided as –
  (i) PC (Professional/ Departmental Core) Courses
  (ii) PE (Program Specific Elective) Courses
  (iii) OE (Open Elective) Courses; and
  (iv) Project Works (PW);
- Specific prescribed Course by AICTE Model Curriculum (on "Research Methodology & IPR").
- Audit Courses (as listed by AITCTE Model Curriculum).

### 3.2.4 Course Nomenclature :

The Curriculum Nomenclature and Course Structure grouping for GNITS M.Tech. Degree Programmes are as listed below:

| *S. No.* | *Broad Course Classification* | *Course Group/ Category* | *Courses Description* | *Credits* |
|---|---|---|---|---|
| 1) | **Core Courses (CoC)** | **PC - Professional Core** | Includes Core subjects related to the Parent Department/ Branch of Engg. | **20** |
| 2) | **Elective Courses (EℓC)** | **PE – Program Specific Elective** | Includes Elective subjects related to the Parent Department/ Branch of Engg. | **15** |
| 3) | | **OE - Open Elective** | Elective Courses which include subjects from other technical and/or Emerging Areas | **3** |
| 4) | **Project Related Courses** | **PW - Project Work** | M.Tech. Project or PG Project or PG Major Project (Phase-I and Phase-II) | **26** |
| | | **Mini-Project with Seminar (MPS)** | Seminar based on core contents related to the Parent Department/ Branch of Engg. in identified specialization | **2** |
| 5) | Prescribed Course | **AICTE Model Curriculum 2018** | Research Methodology & IPR | **2** |
| 6) | Audit Courses | **AICTE Model Curriculum 2018** | Inclusive of AICTE Suggested List | **No Credits** |
| **Total Credits for PGDC** | | | | **68** |

**4.0 Course Work**

**4.1** A student after securing admission, shall pursue and complete the M.Tech. Degree Course in a minimum period of 2 Academic Years (4 Semesters), and/or within a maximum period of 4 Academic Years (starting from the Date of Commencement of I Year).

**4.2** Each student shall register for and secure the specified number of Credits required for the completion of the PG Degree Course and Award of the M.Tech. Degree in the respective Branch of Engineering with the chosen Specialization.

**4.3** The I Year is structured to provide typically 18 Credits in each of the I and II Semesters, and II Year comprises of 16 Credits in each of the I and II semesters, totalling to 68 Credits for the entire M.Tech. Programme.

**5.0 Course Registration**

**5.1** A 'Faculty Advisor' shall be assigned to each M.Tech. Degree Course student with respective Specialization, and the Faculty Advisor assigned shall advise/counsel the student about the M.Tech. Programme Specialization, its Course Structure and Curriculum, Choice/ Option for Subjects/ Courses, based on the competence, progress, pre-requisites and interest of the student.

**5.2** The Academic/Examination Section of the College invites 'Registration Forms' from the students apriori (before the beginning of the Semester) through 'ONLINE SUBMISSIONS' ensuring 'DATE and TIME Stamping'. The ONLINE Registration Requests for any 'CURRENT SEMESTER' shall be completed BEFORE the

commencement of SEEs (Semester End Examinations) of the 'PRECEDING SEMESTER'.

**5.3** A student can apply for ONLINE Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from her assigned Faculty Advisor, which should be submitted to the College Academic/Examination Section through the Head of the Department (a copy of the same being retained with the Head, Faculty Advisor and the Student).

**5.4** A student shall Register for Subjects/Courses of 'her CHOICE' with a total of 18 Credits per semester in the I Year as structured in the Course Curriculum, which will be treated as the Minimum Work Load; she may also seek registration for a maximum of 3 additional/extra credits from those specified for the II Year I Semester (Maximum Work Load thus limited to 21 C) based on her interest, competence, progress, and 'pre-requisites' as indicated for various Subjects/ Courses in the Department Course Structure (for the relevant Specialization) and the Syllabus contents for various Subjects/ Courses, as applicable. All the remaining Credits shall be registered in the II Year-I and II Semesters.

**5.5** The choice for the 'Additional Subjects/ Courses' in the I Year (in any semester, above the typical 18 Credit norm, and within the Maximum Permissible Limit of 21 Credits, as applicable) must be indicated clearly in the ONLINE Registration, which needs the specific approval and the signature of the Faculty Advisor/Counsellor assigned and the Head of the Department on the hard-copy.

**5.6** If the student submits ambiguous choices or multiple options or erroneous entries during ONLINE Registration for the Subject(s)/Course(s) under a given/specified Course Group/Category as listed in the Course Structure for that particular PGDC Specialization, ONLY the first mentioned Subject/Course in that Category will be taken into consideration, as applicable.

**5.7** The Subject/Course Options exercised through ONLINE Registration are final and CANNOT be changed, and CANNOT be inter-changed; further, alternate choices shall also not be considered. However, if the Subject/Course that has already been listed for Registration (by the Head of Department) in a semester could not be offered due to any unforeseen or unexpected reasons, then the student may be allowed to have alternate choice - either for a new Subject (subject to offering of such a Subject), or for another existing Subject (subject to availability of seats), which may be considered. Such alternate arrangements shall be made by the Head of the Department, with due notification and time-framed schedule, within the FIRST WEEK from the commencement of Class-work for that semester.

**5.8** The Dropping of Subjects/ Courses in any semester of the I Year may be permitted, ONLY AFTER obtaining prior approval and signature from the Faculty Advisor (subject to retaining the minimum of specified 18 Credits) 'within 15 Days of Time' from the beginning of the current semester.

**6.0 Class Strength**

**6.1** The typical student strength for each semester shall be 18 (or as per JNTUH / AICTE Approved Intake).

**6.2** A Subject/Course may be offered to the students, ONLY IF a minimum of 50% of the students of a PG Specialization opt for the same.

**6.3** In case of the options for Subjects/Courses coming from students of other Departments/Branches/Disciplines also, PRIORITY shall be given to the student of the 'Parent Department' first.

**7.0 Attendance Requirements**

**7.1** A student shall be eligible to appear for the Semester End Examination (SEE) of any subject, if she acquires a minimum of 75% of attendance in that Subject for that semester.

**7.2** The condoning of shortage of attendance up to 10% in each Subject (for 65% and above, and below 75% attendance cases) of a semester may be granted by the College Academic Committee (CAC) on genuine and valid grounds based on the student's representation with supporting evidence.

**7.3** A stipulated fee per Subject/Course shall be payable towards condoning of shortage of attendance.

**7.4** The Shortage of Attendance below 65% in any Subject shall in NO case be condoned.

**7.5** A student, whose shortage of attendance is not condoned in any Subject(s) in any semester, is considered as 'Detained Student in that Subject(s)', and is not eligible to take End Examination(s) in the Subject(s) detained in that semester; and she has to seek Re-registration for those Subject(s) in subsequent semesters, and attend the same as and when offered.

**7.6** Every student shall put in the minimum required attendance (as specified in Clauses 7.1-7.3) in at least 3 theory subjects and 2 lab courses – (i) in I Year I Semester, for promotion to I Year II Semester, and similarly - (ii) in I Year II Semester along with the 'Mini-Project with Seminar', for promotion to II Year I Semester.

**7.7** A student shall not be promoted to the next semester unless she satisfies the attendance requirements of the present semester, as applicable. In such cases, she may seek readmission into that semester (and register for all semester subjects), as and when offered. When she fulfils the attendance requirements in the present semester, she shall not be eligible for readmission (or re-register) into the same class/semester again.

**8.0 Academic Requirements**

The following Academic Requirements have to be satisfied, in addition to the Attendance Requirements mentioned in Clause 7.0:

**8.1** A student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to each Subject/ Course, if she secures not less than 40% marks (28 out of 70 marks) in the Semester End Examination (SEE), and a minimum of 50% of marks (50 out of 100 marks) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades, this implies securing **'C'** Grade or above in that Subject.

**8.2** A student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to - Mini-Project with Seminar (MPS), in I year II semester if she secures not less than 50% of the total marks allocated. The student would be treated as failed, if she - (i) does not execute the Mini-Project (and prepare the report) as specified by the Supervisor, or (ii) does not present the Seminar as required, or (iii) secures less than 50% of Marks ( < 50 marks) in evaluation. She may have to reappear for the 'Mini-Project with Seminar' evaluation, when it is re-scheduled again in that semester; if she fails in such 'one reappearance' evaluation also, she has to reappear

for the same in the next subsequent semester(s), as and when scheduled, as supplementary candidate.

**8.3** A student shall register for all Subjects covering 68 Credits as specified and listed in the Course Structure for the chosen M.Tech. Degree Specialization, put up all the Attendance and Academic requirements for securing 68 Credits obtaining a minimum of C Grade or above in each Subject, and 'earn all 68 Credits securing SGPA $\geq 5.0$ ( in each semester) and final CGPA (i.e., CGPA at the end of PGDC is to be $\geq 5.0$), to successfully complete the PGDC.

**8.4** The Marks and the Letter Grades obtained in all those Subjects covering the specified 68 Credits alone shall be considered for the calculation of final CGPA, which shall be indicated in the Grade Card of the II Year II Semester.

**8.5** If a student registers for few more 'extra Subjects' (in the parent Department or other Departments/Branches of Engg.) other than those listed Subjects totalling to 68 Credits as specified in the Course Structure, the performances in those 'extra Subjects' (although evaluated and graded using the same procedure as that of the required 68 Credits) shall not be taken into account while calculating the SGPA and CGPA. For such 'extra Subjects' registered, the Letter Grade alone shall be indicated in the Grade Card as a performance measure, subject to the completion of the Attendance and Academic Requirements as stated in Clauses 7.0 and 8.1 – 8.4 above.

**8.6** A student who fails to earn 68 Credits as per the specified Course Structure, and as indicated in Clauses 8.1- 8.5, within 4 Academic Years from the Date of Commencement of her I Year, shall forfeit her seat in M.Tech. Programme and her admission shall stand cancelled.

**8.7** When a student is detained due to the shortage of attendance in any Subject(s) in any semester, no Grade Allotment shall be done for such Subject(s), and SGPA/ CGPA calculations of that semester shall not include the performance evaluations of such Subject(s) in which she gets detained. However, she becomes eligible for re-registration of such Subject(s) (in which she gets detained) in the subsequent semester(s), as and when offered next, with the Academic Regulations of the Batch into which she gets readmitted, by paying the stipulated fees per Subject to the College. In all these re-registration cases, the student shall have to secure a fresh set of Internal Marks (CIE) and Semester End Examination Marks (SEE) for performance evaluation in such Subject(s), and subsequent SGPA/ CGPA calculations.

**8.8** A student eligible to appear for the Semester End Examination (SEE) in any Subject, but is absent at it or failed (failing to secure C Grade or above), may reappear for that Subject at the supplementary examination (Supplementary SEE) as and when conducted. In such cases, her Internal Marks (CIE) assessed earlier for that Subject/ Course shall be retained and added to the marks to be obtained in the supplementary examination (Supplementary SEE) for the evaluation of her performance in that Subject.

## 9.0 Evaluation - Distribution and Weightage of Marks

**9.1** The performance of a student in each semester shall be evaluated Subject-wise (irrespective of the Credits assigned) with a maximum of 100 marks for the Theory or Practicals or Mini-Project with Seminar or Drawing/Design etc; further, Phase-I and Phase-II of the M.Tech. Project Work (in II Year I and II semesters) shall also be evaluated for 100 marks each. These evaluations shall be based on 30% CIE and 70% SEE, and a Letter Grade corresponding to the % of marks obtained shall be given.

**9.2** For all the Subjects/ Courses as mentioned in 9.1**,** the distribution shall be: 30 marks for CIE (Continuous Internal Evaluation), and 70 marks for the SEE (Semester End Examination).

**9.3** **a)** For the Theory Subjects, the CIE marks shall comprise of - Mid-Term Examination marks (for 30 Marks).

**b)** During the semester, there shall be 2 Mid-Term examinations. Each Mid-Term examination shall be for 30 marks (with 120 minutes duration), and the question paper shall contain 2 parts, Part-A is for 06 Marks and shall contain 3 short answer questions of 02 marks each and Part-B is for 24 Marks and shall contain 5 questions of 8 Marks each out of which 3 questions are to be answered. The first Mid-Term examination shall be conducted at the middle of the semester for the first 50% of the syllabus and the second Mid-Term examination shall be conducted at the end of the semester, immediately after the completion of the class work, for the remaining 50% of the syllabus; each shall be evaluated for 30 marks.

**c)** The first mid-term examination marks, shall make the first set of CIE marks, and the second mid-term examination marks shall make the second set of CIE marks; and the AVERAGE of the two sets of mid-term examination marks shall be taken as the final marks secured by the student towards Continuous Internal Evaluation (CIE) in that Theory Subject.

**9.4** For the Lab./Practical Subjects, there shall be a Continuous Internal Evaluation (CIE) during the semester for 30 marks, and Semester End Examination (SEE) at the end of the semester for 70 marks. Out of the 30 marks for Internals, day-to-day work assessment in the laboratory shall be evaluated for 20 marks; and the performance in an internal Lab./Practical Test shall be evaluated for 10 marks. The Semester End Examination (SEE) for Lab./ Practicals shall be conducted at the end of the semester by the Lab. Teacher concerned and another faculty member of the same Department as assigned by the Head of the Department.

**9.5** **a)** There shall be a Mini-Project, preferably in collaboration with an Industry with the relevant specialization to be registered and executed during the I Year II Semester, for about sixteen weeks duration. It shall also carry 100 marks, out of which CIE shall be for 30 marks, and SEE shall be for 70 marks. Marks earned under CIE for the 'Mini-Project with Seminar' shall be awarded by the Mini-Project Guide/Supervisor (based on the continuous evaluation of student's performance during the Mini-Project execution period).

**b)** The Mini-Project work shall be submitted in a Technical Report form, and a presentation of the same shall be made before a Committee as a Seminar, and the 'Mini-Project with Seminar' shall be evaluated by the committee for 70 Marks (SEE). The Committee shall consist of the Head of the Department, the Supervisor of Mini-Project, and a Senior Faculty Member of the Department. Performance evaluation of the 'Mini-Project with Seminar' shall be included in the I Year II Semester Grade Card.

**9.6** **Electives:** 5 Program Specific Elective Courses and 1 Open Elective Course are offered in the 4 Semester PG Degree Course at GNITS, as per AICTE Model Curriculum. Students are to choose each Elective Course from the corresponding Set of Electives given, and the evaluation of the Elective Course shall be the same as that for the Theory Course/Subject.

**9.7** Every student shall be required to execute her M.Tech. Project under the guidance of the Supervisor assigned to her by the Head of the Department, and shall submit her dissertation on a topic relevant to her PG specialization.

**a)** The M.Tech. Project shall start immediately after the completion of the I Year II Semester, and shall be divided and carried out in 2 phases : Phase–I during II Year I Semester, and Phase–II during II Year II Semester. The student shall prepare and submit two independent Project Work Reports - Project Work Report-I shall include the Project Work carried out under Phase–I, and the Project Work Report-II (Final Report) shall include the Project Work carried out under Phase–I and Phase–II put together.

**b)** In Phase-I of the Project Work, the student shall carry out the literature survey, select an appropriate topic and submit a Project Proposal within 6 weeks (immediately after her I Year II Semester End Examinations), for approval by the Project Review Committee (PRC). The PRC shall be constituted by the Head of the Department, and shall consist of the Head of the Department, Project Supervisor, and a Senior Faculty Member of the Department. The student shall present her Project Work Proposal to the PRC (PRC-I Presentation), on whose approval she can 'REGISTER for the M.Tech Project'. Every student shall compulsorily register for her M.Tech. Project Work, preferably within the 6 weeks of time-frame as specified.

**c)** After the Registration, the student shall carry out the work, and periodically submit 'a periodic progress report' to her Supervisor throughout the Project period. The PRC shall monitor the progress of the Project Work and review, based on the PRC-II and PRC-III presentations and performance evaluations – the first one at the middle of the II Year I Semester, and the second one at the end of the II Year I Semester (before the I Semester End Examinations). The student shall also submit the Project Work Report-I to the PRC at PRC-III, for the PRC-III considerations and evaluations.

**d)** 100 marks are allocated for each Phase (Phase-I and Phase-II) of the Project Work, out of which 30 marks shall be for CIE (Continuous Internal Evaluation/CIE), and 70 Marks will be for SEE (Semester End viva-voce Examination).

**e)** The marks earned under CIE for the Phase-I of the Project shall be awarded by the Project Guide/Supervisor (based on the continuous evaluation of student's performance, all her PRC presentations during the Project Work Phase-I period and Project Work Report-I). For SEE marks of Project Phase-I, the Project Work Report-I shall be examined, and viva-voce shall be conducted at the end of the II Year I Semester (along with PRC-III) by the PRC, and the corresponding SEE marks shall be awarded.

**f)** The Phase-II of the Project shall be carried out in the II Year II Semester, and the student's progress and performance evaluation shall be carried out through PRC-IV (at the middle of the II semester), and PRC-V (at the end of the II semester) presentations. The student shall submit the Project Work Report-II (Final Project Report or Dissertation Draft Copy) to the PRC at PRC-V, for the PRC-V considerations and evaluations. Marks earned under CIE for Phase-II of the Project shall be awarded by the Project Guide/Supervisor (based on the continuous evaluation of student's performance, all her PRC presentations during the Project Work Phase-II period and Project Work Report-II). Marks earned under SEE for Phase-II Work shall be awarded by the External Examiner, after the evaluation of the M.Tech. dissertation and the final viva-voce examination of the M.Tech. Project work.

**g)** After the PRC-V presentation, the PRC shall evaluate the entire performance of the student and declare the Project Work as 'Satisfactory' or 'Unsatisfactory'. Every Final Project Work Report (that has been declared 'satisfactory') shall undergo 'Plagiarism Check' as per the University/ College norms to ensure the content plagiarism below a specified level of 30%, and to be acceptable for submission. In case of the unacceptable plagiarism levels, the student shall resubmit the Modified Project Work Report/Dissertation after carrying out the necessary modifications/additions to her Project Work/Report as suggested by the PRC within the specified time.

**h)** If any student could not be present for any PRC at the scheduled time (after approval and registration of her Project Work at the PRC-I), or her progress is considered as 'not satisfactory' at any scheduled PRC, she will have to reappear (within one month period) for the same PRC presentation and evaluation at a later date/time as suggested by the PRC.

**i)** A student is allowed to submit her M.Tech. Project Dissertation 'only after the completion of 40 weeks from the date of approval/registration' of her Project, and after obtaining all the approvals from the PRC. The Extension of time, within the total permissible limits of completion of the PGDC may be considered by the PRC on sufficient valid, genuine grounds.

**j)** The student shall be allowed to submit her M.Tech. Project Dissertation, only on the successful completion of all the prescribed PG Subjects (Theory and Labs.), Mini-Project with Seminar, etc. (securing C Grade or above), and after obtaining all approvals from PRC. In such cases, the M.Tech. dissertation will be sent to an External Examiner nominated by the Principal of the College, from the panel of 3 names of external faculty members (Professors or Associate Professors, outside the college) suggested by the Head of Department, on whose approval, the student can appear for the M.Tech. Project viva-voce Examination, which shall be conducted by a Board, consisting of the PG Project Supervisor, Head of the Department, and the External Examiner who adjudicated the M.Tech. Project Work and Dissertation. The Board shall jointly declare the Project Work Performance as 'satisfactory', or 'unsatisfactory'; and in successful cases, the External Examiner shall evaluate the Student's Project Work presentation and performance for 70 Marks (SEE).

**k)** If the adjudication report of the External Examiner is 'not favourable' , then the student shall revise and resubmit her M.Tech Dissertation after one semester, or as per the time specified by the External Examiner and/ or the PRC. If the resubmitted report is again evaluated by the External Examiner as 'not favourable', then that Dissertation will be summarily rejected. Subsequent actions for such rejected dissertations may be considered, only on the specific recommendations of the External Examiner and/ or PRC.

**l)** In cases, where the Board declared the Project Work Performance as 'unsatisfactory', the student is deemed to have failed in the Project viva-voce Examination, and she may reappear for the viva-voce Examination as per the Board's recommendations. If she fails in the second viva-voce Examination also, she shall not be considered eligible for the Award of the Degree, unless she is asked to revise and resubmit her Project Work by the Board within a specified time period (within 4 years from the date of commencement of her I Year I Semester).

## 10.0 Re-Admission / Re-Registration

### 10.1 Re-Admission for Discontinued Students :

The student who has discontinued the M.Tech. Degree Programme on account of any reasons whatsoever, may be considered for 'Readmission' into the same Degree Programme (with same specialization) with the Academic Regulations of the Batch into which she get readmitted, with prior permission from the authorities concerned, subject to Clause 4.1.

**10.2 Re-Registration for Detained Students :**

When any student is detained in a Subject(s) on account of the shortage of attendance in any semester, she may be permitted to re-register for the same Subject(s) in the 'same category' (Core or Elective Group) or equivalent Subject(s) if the same Subject is not available, as suggested by the BoS Chair of that Department, as and when offered in the sub-sequent semester(s), with the Academic Regulations of the Batch into which she seeks re-registration , with prior permission from the authorities concerned, subject to Clause 4.1.

**11.0 Grading Procedure**

**11.1** The marks shall be awarded to indicate the performance of each student in each Theory Subject, or Lab/Practicals, or Mini-Project with Seminar, or Project etc., and based on the % of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Clause 9.0, a corresponding Letter Grade shall be given.

**11.2** A Letter Grade does not imply any specific % of marks.

**11.3** As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

| *% of Marks Secured (Class Intervals)* | *Letter Grade (UGC Guidelines)* | *Grade Points (GP)* |
|---|---|---|
| **90% and above ( ≥ 90% , ≤ 100% )** | **O (Outstanding)** | **10** |
| **Below 90% but not less than 80% ( ≥ 80% , < 90% )** | **$A^+$ (Excellent)** | **9** |
| **Below 80% but not less than 70% ( ≥ 70% , < 80% )** | **A (Very Good)** | **8** |
| **Below 70% but not less than 60% ( ≥ 60% , < 70% )** | **$B^+$ (Good)** | **7** |
| **Below 60% but not less than 55% ( ≥ 55% , < 60% )** | **B (above Average)** | **6** |
| **Below 55% but not less than 50% ( ≥ 50% , < 55% )** | **C (Average)** | **5** |
| **Below 50% ( < 50% )** | **F (FAIL)** | **0** |

**11.4** A student obtaining F Grade in any Subject shall be considered 'failed', and will be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), in the subsequent semesters, as and when offered. In such cases, her Internal marks (CIE marks) in those Subject(s) will remain same as those she obtained earlier.

**11.5** In general, a student shall not be permitted to repeat any Subject(s) with the sole intention of 'Grade Improvement' or 'SGPA/ CGPA Improvement'. However, she has to repeat all those Subject(s), in which she gets 'detained due to lack of required attendance' (as listed in Clauses 8.7 and 10.2), through Re-Registration at a later date.

**11.6** A student earns Grade Points (GP) in each Subject on the basis of the Letter Grade obtained by her in that Subject. Then, the corresponding 'Credit Points' (CP) are computed by multiplying the Grade Points with Credits for that particular Subject/Project.

**Credit Points (CP) = Grade Points (GP) x Credits**

**11.7** The student passes the Subject/Project only when she gets GP ≥ 5 (C Grade or above).

**11.8** The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (ΣCP) secured from ALL the Subjects/ Seminar/ Comprehensive Viva-voce/Project registered in a Semester by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as:

**SGPA** $= \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \}$ **…. For each semester**,

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N' is the no. of Subjects 'REGISTERED' for the Semester, $C_i$ is the no. of Credits allotted to the ith Subject, and $G_i$ represents the Grade Points (GP) corresponding to the Letter Grade awarded for that ith Subject.

**11.9** The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the Second Semester onwards, at the end of each Semester, as per the formula:

**CGPA** $= \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \}$ **…. For all S Semesters registered**

**(ie., upto and inclusive of S semesters, S ≥ 2 )**,

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of that PGDC Specialization) the student has 'REGISTERED' from the 1st Semester onwards up to and inclusive of the Semester S ( obviously M > N ), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), $C_j$ is the no. of Credits allotted to the jth Subject, and $G_j$ represents the Grade Points (GP) corresponding to the Letter Grade awarded for that jth Subject. After Registration and completion of the I Year I Semester however, the SGPA of that Semester itself may be taken as CGPA, as there are no cumulative effects.

**11.10** For the Merit Ranking or Comparison Purposes or any other listing, ONLY the 'ROUNDED OFF' values of the CGPAs shall be used.

**11.11** For the calculations listed in Clauses 11.6 – 11.10, performance in the failed Subjects/ Courses (securing F Grade) shall also be taken into account, and the Credits of such Subjects/Courses shall also be included in the multiplications and summations.

**11.12 Passing Standards :**

a) A Student shall be declared successful or 'passed' in a semester, only when she gets a SGPA ≥ 5.00 (at the end of that particular Semester); and a student shall

be declared successful or 'passed' in the entire PGDC, only when she gets a CGPA ≥ 5.00; subject to the condition that she secures a GP ≥ 5 (C Grade or above) in every registered Subject/ Course in each semester (during the entire PGDC), for the Award of the Degree, as required.

b) After the completion of each semester, a Grade Card or Grade Sheet (or Transcript) shall be issued to all the registered students of that semester, indicating the Letter Grades and the Credits earned. The Grade Card/Grade Sheet shall show the details of the Courses Registered (Course Code, Title, No. of Credits, Grade Earned), Credits earned, SGPA, and CGPA etc.

**12.0 Declaration of Results**

**12.1** The Computation of SGPA and CGPA are done using the procedure listed in Clauses 11.6 – 11.11.

**12.2** For the Final % of Marks equivalent to the computed CGPA, the following formula may be used

**% of Marks = CGPA x 10**

**13.0 Award of Degree**

**13.1** A student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes all the examinations prescribed in the entire M.Tech. Programme (PGDC), and secures the required number of 68 Credits (with CGPA ≥ 5.0), within the 4 Academic Years from the Date of Commencement of the First Academic Year, shall be declared to have 'QUALIFIED' for the Award of the M.Tech. Degree in the chosen Branch of Engineering, with the Specialization considered at the time of Admission.

**13.2** A student who qualifies for the Award of the M.Tech. Degree (in her chosen Branch/ Specialization) as listed in Clause 13.1, shall be placed in the following Class Divisions:

**13.3** **a)** A student with CGPA (at the end of the PG Degree Course) ≥ 8.00, and fulfilling the following conditions -

(i) should have passed all the Subjects/Courses in 'FIRST APPEARANCE' within the first 2 Academic Years (or 4 Sequential Semesters) from the Date of Commencement of her First Academic Year,

(ii) should have secured a CGPA ≥ 8.00, at the end of each of the first 4 sequential semesters, starting from the I Year I Semester onwards,

(iii) should not have been detained or prevented from writing the End Semester Examinations in any Semester due to the shortage of attendance or any other reason

**shall be placed in 'FIRST CLASS with DISTINCTION'**.

**b)** A student with CGPA ≥ 8.00 , but has not fulfilled the conditions under Clause 13.3 (a) shall be placed in 'FIRST CLASS'.

**13.4** A student with CGPA (at the end of the PG Degree Course) ≥ 6.50 but < 8.00, shall be placed in 'FIRST CLASS'.

**13.5** A student with CGPA (at the end of the PG Degree Course) ≥ 5.00 but < 6.50, shall be placed in 'SECOND CLASS'.

**13.6** A student with CGPA (at the end of the PG Degree Course) < 5.00 will not be eligible for the Award of the Degree.

**13.7** A student fulfilling the conditions listed under Clause 13.3 (a) alone, shall be the eligible candidate for the 'University Rank' and 'Gold Medal' considerations.

**14.0 Withholding of Results**

**14.1** If a student has not paid fees to the University/ College at any stage, or has pending dues against her name on account of any reason whatsoever, or if any case of indiscipline is pending against her, the result of such student may be withheld, and she shall not be allowed to into the next higher semester. The Award or issue of the Degree may also be withheld in such cases.

**15.0 Transitory Regulations**

**15.1** A student who has discontinued for any reason, or has been detained for want of attendance or lack of required credits as specified, or who has failed in her M.Tech. Degree Course after the PGDC period of 2 years, may be considered eligible for readmission - to the same PGDC with same set of Subjects/ Courses (or equivalent Subjects/ Courses as the case may be), and/or to the same Program Specific Electives (or from same set/category of Electives or equivalents as suggested), as and when they are offered (within the time-frame of 4 years from the Date of Commencement of her I Year I Semester), along with the Academic Regulations of the Batch into which she gets readmitted.

**16.0 Student Transfers**

**16.1** There shall be no Branch/ Specialization transfers after the completion of the Admission Process.

**17.0 Scope**

i) Where the words "Subject" or "Subjects", occur in these regulations, they also imply "Course" or "Courses".

ii) The Academic Regulations should be read as a whole, for the purpose of any interpretation.

iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

iv) The College may change or amend the Academic Regulations, Course Structure or Syllabi at any time, and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the College Authorities.

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## MALPRACTICES RULES

## DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

| | Nature of Malpractices/Improper conduct | Punishment |
|---|---|---|
| | If the student: | |
| 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 student is appearing but has not made use of (material shall include any marks on the body of the student 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. |
| (b) | Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student 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 students 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 student is appearing. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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.<br>The hall ticket of the student is to be cancelled and sent to the university. |

| | | |
|---|---|---|
| 3. | Impersonates any other student in connection with the examination. | The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student 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 student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 student 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 student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 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 student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students 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 student 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 student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 student 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 student is also debarred and forfeits the seat. |

| | | |
|---|---|---|
| 9. | If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8. | Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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 student is also debarred and forfeits the seat.<br><br>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 student 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 student 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 Principal for further action to award suitable punishment. | |

**G. NARAYANAMMA INSTITUTE OF TECHNOLOGY & SCIENCE (For Women)**

**(AUTONOMOUS)**

**Shaikpet, Hyderabad– 500104**

## M. TECH 2 YEAR (4 SEMESTERS) REGULAR PROGRAMME IN DIGITAL ELECTRONICS AND COMMUNICATION ENGINEERING (DECE)

### COURSE STRUCTURE

**(Applicable for the batch admitted from the academic year 2018-19 onwards)**

**I YEAR** **I SEMESTER**

| S.No | Group | Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1) | PC-1 | Advanced Digital System Design | 3 | - | - | 3 |
| 2) | PC-2 | Wireless and Mobile Communications | 3 | - | - | 3 |
| 3) | PE-1 | 1)VLSI Technology and Design<br>2) Advanced Computer Architecture<br>3)System on Chip Architecture | 3 | - | - | 3 |
| 4) | PE-2 | 1)Advanced Digital Signal Processing<br>2)Detection and Estimation Theory<br>3)Coding Theory and Techniques | 3 | - | - | 3 |
| 5) | PCL-1 | Advanced Digital System Design Lab | - | - | 4 | 2 |
| 6) | PCL-2 | Wireless and Mobile Communications Lab | - | - | 4 | 2 |
| 7) | PW | Research Methodology & IPR | 2 | - | - | 2 |
| 8) | AC-1 | AUDIT COURSE 1 | 2 | - | - | - |
| | **Total Credits** | | **16** | **-** | **8** | **18** |

**I YEAR** **II SEMESTER**

| S.No | Group | Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1) | PC-3 | Microcontrollers and Programmable Digital Signal Processors | 3 | - | - | 3 |
| 2) | PC-4 | Advanced Communication Networks | 3 | - | - | 3 |
| 3) | PE-3 | 1)Embedded System Design<br>2)Low power VLSI Design<br>3)Design of Fault Tolerant Systems | 3 | - | - | 3 |
| 4) | PE-4 | 1)Digital Image and Video Processing<br>2) Machine Learning<br>3)Wireless Sensor Networks | 3 | - | - | 3 |
| 5) | PCL-3 | Microcontrollers and Programmable Digital Signal Processors Lab | - | - | 4 | 2 |
| 6) | PCL-4 | Advanced Communication Networks Lab | - | - | 4 | 2 |
| 7) | PW | Mini Project with Seminar | - | - | 4 | 2 |
| 8) | AC-2 | Audit Course 2 | 2 | - | - | - |
| | **Total Credits** | | **14** | **-** | **12** | **18** |

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**COURSE STRUCTURE**

**(Applicable for the batch admitted from the academic year 2018-19 onwards)**

**II YEAR** **I SEMESTER**

| S.No | Group | Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1) | PE-5 | 1)MIMO Systems<br>2)Real Time Operating Systems<br>3)Internet of Things and Applications | 3 | - | - | 3 |
| 2) | OE | Open Elective | 3 | - | - | 3 |
| 3) | PW | Project Phase – 1 | - | - | - | 10 |
| | | **Total Credits** | **6** | **-** | **-** | **16** |

**II YEAR** **II SEMESTER**

| S.No | Group | Subject | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1) | PW | Project Phase - 2 | - | - | - | 16 |
| | | **Total Credits** | **-** | **-** | **-** | **16** |

**Total 68 Credits**

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## M. TECH 2 YEAR (4 SEMESTERS) REGULAR PROGRAMME IN DIGITAL ELECTRONICS AND COMMUNICATION ENGINEERING (DECE)

**(Applicable for the Batch admitted from the Academic Year 2018-19 onwards)**

### List of Open Electives (OE) offered by Various Departments

| S.No. | Course Title | Offering Department |
|---|---|---|
| 1. | Business Analytics | Humanities and Management |
| 2. | Industrial Safety | Mechanical Engineering |
| 3. | Operations Research | Mechanical Engineering |
| 4. | Cost Management of Engineering Projects | Humanities and Management |
| 5. | Composite Materials | Basic Sciences |
| 6. | Energy from Waste | Electrical and Electronics Engineering |
| 7. | Power from Renewable Energy Sources | Electrical and Electronics Engineering |

### List of Audit Courses (AC-1) offered by various Departments during I-Semester

| S.No. | Course Title | Offering Department |
|---|---|---|
| 1. | English for Research Paper Writing | Humanities and Management |
| 2. | Disaster Management | Basic Sciences |
| 3. | Pedagogy Studies | Humanities and Management |
| 4. | Personality Development through Life Enlightenment Skills | Humanities and Management |

### List of Audit Courses (AC-2) offered by various Departments during II-Semester

| S.No. | Course Title | Offering Department |
|---|---|---|
| 1. | Sanskrit for Technical Knowledge | Humanities and Management |
| 2. | Value Education | Humanities and Management |
| 3. | Constitution of India | Humanities and Management |
| 4. | Stress Management by Yoga | Humanities and Management |

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## ADVANCED DIGITAL SYSTEM DESIGN (PC-1)

**Prerequisites:** Digital System Design

**Course Objectives:**

1. To understand number systems, conversion between different number systems, fixed and floating point number systems in digital electronic circuits.
2. To analyze combinational logic circuits using basic gates.
3. To implement Subsystem design using combinational blocks
4. To design finite State machines.
5. To implement Subsystem design using sequential blocks.

**UNIT 1:** (~8 Lecture Hours)
**Processor Arithmetic:** Two's Complement Number System- Arithmetic Operations, Fixed-point Number System, Floating Point Number system - IEEE 754 format, Basic binary Codes, one hot encoding

**UNIT 2:** (~10 Lecture Hours)
**Combinational Circuits:** CMOS logic design, Static and dynamic analysis of combinational circuits, timing hazards. Functional blocks: Decoders, Encoders, Three-state devices, Multiplexers, Parity circuits, Comparators, Adders, Subtractors, Carry look-ahead adder – timing analysis. Combinational multiplier structures.

**UNIT 3:** (~10 Lecture Hours)
**Sequential Logic:** Latches and Flip-Flops, Sequential logic circuits- timing analysis (Set up and hold times), State machines- Mealy & Moore machine analysis, FSM design Using D Flip-Flops, FSM optimization and partitioning, Synchronizers and Metastability. FSM Design examples: Vending machine, Traffic light controller, Washing machine.

**UNIT 4:** (~10 Lecture Hours)
**Subsystem Design using Functional Blocks 1:** Design (including Timing Analysis) of different logical blocks of varying complexities involving mostly combinational circuits**:** ALU, 4-bit combinational multiplier, Barrel shifter, Simple fixed point to floating point encoder, Dual Priority encoder, and Cascading comparators.

**UNIT 5:** (~8 Lecture Hours)
**Subsystem Design using Functional Blocks 2:** Design, (including Timing Analysis) of different logical blocks of different complexities involving mostly sequential circuits**:** Pattern (sequence) detector, Programmable Up-down counter, Round robin arbiter with 3 requesters, Process Controller, FIFO.

**Text Books:**

1. John F. Wakerly, "Digital Design", 3rd Edition, Prentice Hall, 2002.
2. R.P .Jain "Modern Digital Electronics", 4th Edition, Tata McGraw Hill, 2009.

**Reference Books:**

1. M. Morris Mano, "Digital design", 2nd Edition, Prentice Hall, 2000.
2. Wayne Wolf, "Modern VLSI Design", 4th Edition, PHI Learning Pvt Ltd., 2010.
3. William Stallings, "Computer Organization &Architecture", 6th edition, Prentice Hall Of India Pvt Ltd. 2003.
4. Michael D.Ciletti, "Advanced digital System Design with Verilog HDL", 4th Edition, PHI Learning Pvt Ltd., 2013.
5. Stephen Brown, Zvonko Vranasic, "Fundamentals Of Digital System Design with VHDL Design", 2nd edition, Tata McGraw-Hill company Ltd, 2002.

**Online Resources:**

1. http://www.nesoacademy.org/
2. https://onlinecourses.nptel.ac.in/noc18 ee33 -Prof.Santanu Chattopadhyay IITK

**Course Outcomes:** At the end of the course the student will be able to

1. Perform the arithmetic operations and code conversions.
2. Design and Analyze combinational logic circuits.
3. Verify the timing analysis of sequential logic circuits.
4. Design finite state machines.
5. Design combinational systems using combinational blocks.
6. Analyze and Design sequential systems using sequential blocks.

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## WIRELESS AND MOBILE COMMUNICATIONS (PC-2)
## (Common to DECE, WMC)

**Prerequisites**: 1. Wireless Communications 2. Cellular Mobile Communications

**Course objectives:**

1. To analyze wireless and mobile Cellular Communication systems over a stochastic fading channel.
2. To impart the concepts of Multiple Access Techniques.
3. To analyze the concepts of Mobile Radio Propagation, fading and diversity reception techniques.
4. To provide the knowledge on digital cellular systems

**UNIT 1:** (~11 Lecture Hours)
**Cellular Communication Fundamentals:** Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and system capacity, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems–cell splitting, sectoring, Comparison of 1G, 2G, 3G & 4G.

**UNIT 2:** (~10 Lecture Hours)
**Mobile Radio Propagation**: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Outdoor Propagation Models-Okumura model, HATA model, Indoor Propagation Models-partition losses (same floor),partition losses between floors, Log distance path loss model, Ericsson multiple break point model, Attenuation factor model , Signal Penetration into Buildings.

**UNIT 3:** (~8 Lecture Hours)
**Small Scale Fading and Multipath**: Small scale multipath propagation, Impulse Response Model, small scale Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading

**UNIT 4:** (~8 Lecture Hours)
**Equalization:** Fundamentals of Equalization, Training a Generic Adaptive Equalizer, Equalizers in a communications receiver, classification of equalization techniques. Linear Equalizers, Nonlinear Equalization, Algorithms for adaptive equalization.
**Diversity:** Diversity techniques, space, frequency diversity, Time Diversity, RAKE Receiver

**UNIT 5:** (~8 Lecture Hours)
**Multiple Access Techniques:** Introduction to multiple access, FDMA, TDMA and CDMA, and their comparison.

**OFDM**-Basic principles, Block diagram and Mathematical representation
**CDMA:** CDMA Digital Cellular Standard (IS-95), Forward CDMA Channel, Reverse CDMA Channel.

**Text Books:**

1. T.S.Rappaport, "Wireless Communications, Principles and Practice", 2nd edition, PHI, 2010.
2. William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 2006.
3. UpenaDalal, "Wireless Communication", Oxford University Press, 8th Impression, 2015.

**Reference Books :**

1. KavehPahLaven and P. Krishna Murthy," Principles of Wireless Networks-, Pearson Education, 2006.
2. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
3. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
4. Asha Mehrotra, "A GSM system Engineering", Artech House Publishers Bosten,
   London,1997.
5. Mischa Schwartz, "Mobile wireless communications", Cambridge university press,2013.

**Online Resources:**

1. http://onlinecources.nptel.ac.in/noc18_ee29 (Introduction to wireless cellular communications by Prof.David Koilpillai,IITM)
2. http://onlinecources.nptel.ac.in/noc18_ee21 (Principles of signal Estimation for MIMO/OFDM wireless communications by Prof. Aditya.K Jagannadham, IITK,)

**Course Outcomes:** At the end of this course, students will be able to

1. Design appropriate mobile communication systems.
2. Apply frequency-reuse concept in mobile communications.
3. Distinguish various multiple-access techniques of mobile communications.
4. Analyze path loss, interference for wireless telephony in mobile communication system.
5. Analyze CDMA system concepts.
6. Comprehend the concepts on fading, diversity and equalisation.

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## VLSI TECHNOLOGY & DESIGN (PE-1)

**Prerequisites :** Digital System Design

**Course Objectives:**

1. To understand the fabrication technology and fabrication process of MOS, CMOS and BiCMOS technology.
2. To demonstrate the general characteristics of MOS transistor and CMOS inverter.
3. To estimate the quality metrics of a digital design.
4. To design and develop combinational and sequential circuits.

**UNIT 1:** (~8 Lecture Hours)
**Fabrication Technologies:** Crystal growth and Wafer preparation, Epitaxy, Oxidation, Lithography, Etching, Diffusion, Ion Implantation, Metallization. Technology Scaling and Road map, Scaling issues.

**UNIT 2:** (~8 Lecture Hours)
**Fabrication Process:** NMOS structure and its static behaviour, Standard 4 mask NMOS Fabrication process, MOS process, CMOS process, BiCMOS process, SOI, Latch up and Latch up condition.

**UNIT 3:** (~12 Lecture Hours)
**Review:** Basic MOS structure and its static behavior.
**Quality Metrics of a Digital Design:** Cost, Functionality, Robustness, Power, and Delay, Stick diagram and Layout, wire delay models of MOS transistors.
**Inverter:** Static CMOS inverter, switching threshold and noise margin concepts and their evaluation, Dynamic behavior, Power consumption.

**UNIT 4:** (~12 Lecture Hours)
**Combinational Logic:** Static CMOS design, Logic effort, Ratioed logic, Pass transistor logic, Dynamic logic, Speed and power dissipation in dynamic logic, Cascading dynamic gates, CMOS transmission gate logic.
**Advanced Technologies:** Giga-scale dilemma, Short channel effects, High–k, Metal Gate Technology, FinFET, TFET etc.

**UNIT 5:** (~8 Lecture Hours)
**Sequential Logic:** Static latches and registers, Bi-stability principle, MUX based latches, Static SR flip-flops, Master-slave edge-triggered register, Dynamic latches and registers, Concept of pipelining, Pulse registers, and Non-Bistable sequential circuit.

**Physical Design Flow:** Floor planning, Placement, Routing, CTS, Power analysis and IR drop estimation-static and dynamic, ESD protection-human body model, Machine model.

**Text Books :**

1. S.M. Sze, "VLSI Technology", 2nd Edition, Tata McGraw-Hills company Ltd, 2005.
2. Pucknell, D.A. and Eshraghian, K., "Basic VLSI Design", PHI, 3rd Edition, 2012.
3. J.P.Rabacy, A.P.Chandrakaran, B.Nikolic, "Digital Integrated Circuits: A design Perspective", Prentice Hall Electronics & VLSI series, 2nd Edition.

**Reference Books :**

1. Baker, Li, Boyce, "CMOS Circuit Design, Layout, and Simulation", 2nd Edition.Wiley.
2. R. J. Baker, "CMOS circuit Design, Layout and Simulation", IEEE Inc., 2008.
3. Kang. S and Leblebici .Y, "CMOS Digital Integrated Circuits, Analysis and Design", 3rdEdition, TMH.

**Online Resources:**

1. https://www.ed.youth4work.com.
2. https://onlinecourses.nptel.ac.in/noc.

**Course Outcomes:** At the end of the course the student will be able to

1. Construct NMOS, PMOS, CMOS, and BiCMOS transistors using various fabrication technologies.
2. Analyze the quality metrics of combinational circuits.
3. Acquire the knowledge in advanced technologies.
4. Design combinational and sequential circuits.
5. Analyze power dissipation and delays in sequential circuits.
6. Familiarize with the concepts of floor plan, placement and routing of the physical design.

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## ADVANCED COMPUTER ARCHITECTURE (PE-1)

**Prerequisites:** 1**.** Digital System Design 2. Computer Organization

**Course Objectives:**

1. Discuss about the computer architecture, which stresses the underlying design principles.
2. Understand the impact of pipelining and parallel processing on computer performance.
3. Study the design methodology, processor design and control design.
4. Describe memory organization, system organization, and parallel processing.

**UNIT 1:** (~8 Lecture Hours)
**Parallel Processing and Pipelining Processing:** Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture.

**UNIT 2:** (~10 Lecture Hours)
**Pipeline Architectur**e: Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.

**UNIT 3:** (~8 Lecture Hours)
**Vector and Array Processor:** Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.

**UNIT 4:** (~12 Lecture Hours)
**Multiprocessor Architecture:** Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).
**Multithreaded Architecture:** Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.

**UNIT 5:** (~10 Lecture Hours)
**Parallel algorithms for multiprocessors:** Classification and performance of parallel algorithms, operating systems for multiprocessors systems, Message passing libraries for parallel programming interface, PVM (in distributed memory system), Message Passing Interfaces (MPI).

**Text Books:**

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing" McGraw Hill Education, 2012.
2. Kai Hwang, "Advanced Computer Architecture", McGraw Hill Education, 1993.

**Reference Books:**

1. William Stallings, "Computer Organization and Architecture, Designing for Performance" Prentice Hall, 6th edition, 2006.
2. John L. Hennessy, David A. Patterson, ".Computer Architecture: A Quantitative Approach", Elsevier, 5th Edition, 2012.
3. Kai Hwang, "Scalable Parallel Computing", McGraw Hill Education, 1998.
4. Harold S. Stone "High-Performance Computer Architecture", Addison-Wesley, 1993.

**Online Resources:**

1. http://nptel.ac.in/courses/106102062/
2. http://nptel.ac.in/courses/106105033/
3. https://www.tutorialspoint.com/parallel_computer_architecture/parallel_computer_architecture_models.htm

**Course Outcomes:** At the end of this course students will be able to

1. Contrasting parallelism and pipelining concepts, the design aspects and challenges.
2. Evaluate the issues in vector and array processors.
3. Study and analyze the high performance scalable multi threaded and multiprocessor systems.
4. Learn about parallel algorithms for multiprocessors.
5. Know the memory contention and different arbitration techniques
6. Illustrate various synchronization techniques for parallel programming interface

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## SYSTEM ON CHIP ARCHITECTURE (PE-1)

**Prerequisites:** 1. Microprocessors and Microcontrollers 2. VLSI Design

**Course Objectives:**

1. To understand the system Architecture.
2. To compare different memory designs and their purposes
3. To interpret the architectures and applications of various interconnect buses.
4. To apply the knowledge of SoC design in different applications.

**UNIT 1:** (~9 Lecture Hours)
**Introduction to the System Approach:** System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory, and Addressing. System level interconnection, An approach for SoC Design, System Architecture and Complexity.

**UNIT 2:** (~8 Lecture Hours)
**Processors:** Introduction , Processor Selection for SoC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

**UNIT 3:** (~12 Lecture Hours)
**Memory Design for SoC:** Overview of SoC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SoC Memory System, Models of Simple Processor – memory interaction.

**UNIT 4:** (~9 Lecture Hours)
**Interconnect Customization and Configuration:** Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SoC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism.

**UNIT 5:** (~10 Lecture Hours)
**Application studies and Case Studies:** SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression

**Text Books:**

1. Michael J. Flynn and Wayne Luk, "Computer System Design System on Chip", Wiley India Pvt. Ltd. October, 2011.
2. Steve Furber, "ARM System on Chip Architecture", Addison Wesley Professional 2nd Ed., 2000.

**Reference Books :**

1. Ricardo Reis, "Design of System on a Chip: Devices and Components", 1st Ed, Springer Publishers, 2004.
2. Jason Andrews, "Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)", 1st Ed, Elsevier publications,2004.

**Online Resources**

1. https://www.arm.com/resources/education/online-courses/introduction-to-system-on-chip-design.
2. http://nptel.ac.in/courses/108102045/10.
3. https://onlinecourses.nptel.ac.in/noc18_cs50

**Course Outcomes:** At the end of the course the student will be able to

1. Acquire the knowledge of all the components required for System design.
2. Evaluate the performance of a system on chip by minimizing the delays.
3. Develop the analytical skill for deciding the type of processor required to design a SoC for the required application.
4. Classify the types and applications of different memory devices.
5. Analyse different types of interconnect buses required for different applications.
6. Understand a configurable device based on the application requirement for a system on chip

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## ADVANCED DIGITAL SIGNAL PROCESSING (PE-2)
## (Common to DECE, WMC)

**Prerequisites:** Digital Signal Processing

**Course Objectives:**
1. To develop an understanding on Digital filter design and Structures in filter implementation.
2. To analyze the finite word length effects in Filter implementation.
3. To understand the importance of Multirate digital signal processing and Applications.
4. To have in-depth knowledge of Linear Prediction and power spectral estimation methods

**UNIT 1:** (~10 Lecture Hours)
**Digital filters:** Theory of FIR, IIR digital filters and their differences, Structures for FIR Systems-Lattice Structure, Structures for IIR Systems-Lattice and Lattice-ladder.
**Finite word length effects in digital Filters** : Analysis of direct form IIR structures, scaling in fixed point implementation of IIR systems, analysis of direct form FIR systems, limit cycles due to round off & truncations, limit cycles due to overflow, avoiding limit cycles.

**UNIT 2:** (~10 Lecture Hours)
**Multirate Digital Signal Processing**: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter design and Implementation for Sampling – Rate conversion- Direct –Form FIR Filter Structures, Polyphase filter structures. Multistage Implementation of Sampling Rate Conversion.
**Applications of Multi Rate Signal Processing:** Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Digital Filter Banks, Sub-band Coding of Speech Signals, Quadrature Mirror Filters, Trans-multiplexers, Over Sampling A/D and D/A Conversion.

**UNIT 3:** (~8 Lecture Hours)
**Linear Prediction and Optimum Linear filters:** Representation of Stationary Random Process- Rational Power Spectra, Relationships between the filter parameters and Autocorrelation Sequence. Forward and Backward linear Prediction, Solution of Normal Equations-Shur Algorithm, AR Lattice and ARMA lattice ladder filters, Wiener filters for filtering and prediction.

**UNIT 4:** (~9 Lecture Hours)
**Non-Parametric Methods of Power Spectral Estimation**: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman-Tukey methods, Performance Characteristics of Nonparametric

Power Spectrum Estimators. Computational Requirements of Non-Parametric Power Spectrum Estimates.

**UNIT 5:** (~8 Lecture Hours)
**Parametric Methods of Power Spectrum Estimation:** Relation between auto correlation & model parameters, AR Models - Yule-Walker & Burg Methods, MA Model for Power Spectrum Estimation, ARMA Model for Power Spectrum Estimation.

**Text Books:**

1. John G. Proakis and Dimitris C. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", 4th Edition, Prentice Hall of India, Pvt. Limited,2007
2. Alan V. Oppenheim, Ronald W. Schaffer, "Discrete Time Signal Processing", 2nd Ed, PHI, 2007.
3. Emmanuel C. Ifeachor, Barrie W. Jervis. Addison "Digital Signal Processing: A Practical Approach", 2nd Edition, Pearson, 2002.

**Reference Books :**

1. S. M .Kay, "Modern spectral Estimation techniques", 1st Edition, PHI, 1997.
2. P.P. Vaidyanathan "Multi Rate Systems and Filter Banks", Pearson Education, 1993.
3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", 2nd Edition, Tata McGraw Hill, 2011.

**Online Resources:**

1. http://www-syscom.univ-mlv.fr/~zaidi/teaching/dsp-esipe-oc2/
2. http://www.ee.oulu.fi/~harza/spect_estim/contents.html

**Course Outcomes:** At the end of this course, students will be able to

1. Design and Analyse the digital filters.
2. Obtain the complete knowledge of Structure in digital filters.
3. Comprehend the Finite word length effects in DSP Systems.
4. Acquire the basics of Multi rate digital signal processing and applications.
5. Interpret the concepts Linear prediction.
6. Analyse the different Power Spectrum Estimation methods.

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## DETECTION AND ESTIMATION THEORY (PE-2)
## (Common to DECE, WMC)

**Prerequisites:** Digital Communications

**Course Objectives:**
1. To build the mathematical background of Signal Detection and Estimation.
2. To understand the spectral and temporal characteristics of random signal.
3. To apply Classical and Bayesian approaches to formulate and solve problems for parameter estimation from noisy signals.
4. To design and analyze Optimum Detection schemes.

**UNIT 1**: (~8 Lecture Hours)
**Review of Vector Spaces**: Vector Spaces and Subspaces, Linear Independence, Basis and Dimension, Linear Transformations, Orthogonality – Orthogonal Vectors and Subspaces, Orthogonal Bases and Gram-Schmidt Orthogonalization.

**UNIT 2:** (~8 Lecture Hours)
**Stochastic Process:** Temporal Characteristics –The Stochastic Process Concept, Stationarity and Independence, Time Averages and Ergodicity, Correlation Functions, Gaussian Random Processes, Poisson Random Process, Random Signal Response of Linear System.

**UNIT 3:** (~8 Lecture Hours)
**Introduction to Estimation Theory:** Minimum variance Unbiased Estimation, Cramer-Rao lower bound – Estimator Accuracy Consideration, Bound, General CRLB for signals in White Gaussian Noise, Transformation of Parameters, Linear Models.

**UNIT 4:** (~10 Lecture Hours)
**Estimators:** Best linear unbiased estimator (BLUE)**,** Maximum Likelihood Estimator (MLE) –Finding the MLE, Properties, MLE for Transformed Parameters, Extension to Vector Parameters, General Bayesian Estimator – Risk Functions, MMSE Estimator, MAP Estimator, Performance description.

**UNIT 5**: (~11 Lecture Hours)
**Detection Theory:** Neyman Pearson Theorem, Receiver Operating Characteristics, MPE, Baye's Risk, Multiple Hypotheses Testing, Minimum Baye's Risk Detector – Binary and Multiple Hypotheses, Deterministic Signals – Matched Filters, Generalized Matched Filters, Multiple Signals (Only Binary Case), Random Signals – Estimator Correlator.

**Text Books:**

1. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", Pearson, 2010.
2. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume II: Detection Theory", Pearson, 2010.
3. Peyton Z. Peebles, "Probability, Random Variables & Random Signal Principles", 4th Edition, TMH, 2010.
4. Gilbert Strang, "Linear Algebra and its Applications", 5th Edition, Brooks/Cole Thomson Learning, 2016.

**Reference Books:**

1. Thomas Kailath, BabakHassibi, Ali H. Sayed, "Linear Estimation", Prentice Hall, 2000.
2. H. Vincent Poor, "An Introduction to Signal Detection and Estimation", 2nd Edition, springer 1998.

**Online Resources:**

1. http://nptel.ac.in/courses/117103018/

**Course Outcomes:** At the end of this course, students will be able to

1. Comprehend with the mathematical background of Signal Detection and estimation.
2. Acquire basics of statistical decision theory used for Signal Detection and Estimation.
3. Examine the detection of deterministic and random signals using statistical models.
4. Test the performance of signal parameters using optimal estimators.
5. Analyze signal estimation in discrete-time domain using filters.
6. Choose the appropriate detection and estimation methods to solve the real time problems.

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## CODING THEORY AND TECHNIQUES (PE-2)
## (Common to DECE, WMC)

**Prerequisites**: Digital Communications

**Course Objectives:**

1. To expose the students to the principles of Error- correcting codes, and their applications to communication systems with noise.
2. To understand the methods for speedy/ compact Error Detection and Correction.
3. To compare different Error Detection and Correction schemes.
4. To analyze latest Channel Coding Techniques.

**UNIT 1:** (~9 Lecture Hours)
**Coding for Reliable Digital Transmission and Storage:** Types of Errors, Error Control Strategies.
**Linear Block Codes:** Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes. Applications of Block codes for Error control in data storage system-Error Control for Computer main processor and control storages, Error Control for Magnetic tapes.

**UNIT 2:** (~10 Lecture Hours)
**Cyclic Codes:** Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, Shortened Cyclic Codes, Error-Trapping decoding for Cyclic Codes- Error Trapping decoding, Improved Error-Trapping decoding, One Step Majority logic decoding for Cyclic Codes, Introduction to Galois field, Description of BCH codes, Decoding procedure for BCH codes.

**UNIT 3:** (~8 Lecture Hours)
**Convolutional Codes:** Encoding of Convolutional Codes, Structural and Distance Properties, Viterbi Decoding, Sequential decoding-The Stack Algorithm, The Fano Algorithm, Majority- Logic Decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ System.

**UNIT 4**: (~10 Lecture Hours)
**Turbo Codes:** Turbo Codes Concepts, Log-Likelihood Algebra, Product Code Example, Encoding with Recursive Systematic Codes, A Feedback Decoder, The MAP Algorithm, MAP Decoding Example.

**UNIT 5:** (~8 Lecture Hours)
**LDPC Codes:** LDPC Codes- Codes based on sparse graphs, Decoding for Binary Erasure Channel, Log-Likelihood Algebra, Belief Propagation, Product Codes,

Iterative Decoding of Product Codes, Concatenated Convolutional Codes- Parallel Concatenation, The UMTS Turbo Code, Serial Concatenation, Parallel Concatenation.

**Text Books:**

1. Shu Lin, Daniel J.Costello,Jr, "Error Control Coding- Fundamentals and Applications", 1st and 2nd Editions, Prentice Hall, 2011, 2013.
2. Bernard Sklar, "Digital Communications-Fundamentals and Applications", 2nd Edition, PEA, 2013.
3. Andre Neubauer, Jurgen Freadenberger, Volker Kuhn, "Coding Theory-Algorithms, Architectures and Applications", 1st Edition, John Wiley & Sons Ltd, 2007.

**Reference Books:**

1. J. Das, "Review of Digital communications", 2nd Edition, New age international publishers, 2013
2. Man Young Rhee, "Error Correcting Coding Theory", McGraw-Hill Publishing, 1989.
3. John G. Proakis, "Digital Communications", 5th Edition, Tata McGraw-Hill, 2008.
4. Todd K.Moon, "Error Correction Coding-Mathematical Methods and Algorithms", Wiley India, 2006.
5. Ranjan Bose, "Information Theory, Coding and Cryptography", 2nd Edition, Tata McGraw-Hill, 2009.

**Online Resources:**

1. http://nptel.ac.in/courses/117106031/

**Course Outcomes:** At the end of this course, students will be able to

1. Relate the capabilities, Probability of Error Detection and Correction using various methods.
2. Estimate the apriori Probabilities for better Error Detection and Correction.
3. Develop the Optimal paths of Detecting and Correcting Errors.
4. Use Majority Logic Decoding in different Error Correcting Codes.
5. Implement Iterative techniques to simplify Error Detection and Correlation.
6. Apply these Error Correcting Codes in various practical applications.

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**ADVANCED DIGITAL SYSTEM DESIGN LAB (PCL-1)**

**Prerequisites:** Digital System Design

**Course Objectives:**

1. To verify the functionality of basic logic gates, combinational circuits, sequential circuits using Verilog/VHDL programming language.
2. To implement various combinational and Sequential circuits using FPGA kits.
3. To perform the circuit simulation for CMOS inverter, Exclusive-OR gate and full adder circuits

**Part I:**

Programming is done using Verilog/VHDL simulator. Download the programs on FPGA/CPLD boards and testing is done using pattern generator (32 channels) and logic analyzer apart from verification by simulation with XILINX and Mentor Graphics tools.

1. a) HDL code to realize all the logic gates
   b) Design and Simulation of adder, Serial Binary Adder, Multi Precession Adder, Carry Look Ahead Adder.
2. Design and implementation of 2-to-4 decoder
3. Design and implementation of 8-to-3 encoder (without and with priority)
4. Design and implementation of 8-to-1 multiplexer
5. Design and implementation of 4 bit binary to gray converter
6. Design and implementation of Multiplexer/ Demultiplexer and Comparator
7. Design and implementation of Full adder using 3 modeling styles
8. Design and implementation of flip flops: SR, D, JK, T.
9. Design and implementation of 4-bit binary, BCD counters (synchronous/ asynchronous reset) or any Sequence counter.
10. Design of an N- bit Register of Serial- in Serial –out, Serial in parallel out, Parallel in serial out and Parallel in Parallel Out.
11. Design of Sequence Detector (Finite State Machine- Mealy and Moore Machines).
12. Design of 4- Bit Multiplier, Divider.
13. Design of ALU to Perform – ADD, SUB, AND-OR, 1's and 2's Compliment, Multiplication, and division.
14. Design of Finite State Machine-Parity Generator and Checker.

**Part II:**

1. Simulation and Layout Design of CMOS Inverter (Static and Dynamic Characteristics).
2. Implementation of EX-OR gate using CMOS, Pseudo-NMOS, Dynamic and Domino Logic style.
3. Implementation of Full Adder using Transmission Gate.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc18 cs48 -Prof.Indranil Senguptha IITK

**Course Outcomes:** At the end of this course, students will be able to

1. Simulate all basic logic gates.
2. Simulate and synthesize various combinational logic circuits.
3. Simulate and synthesize various sequential logic circuits.
4. Analyze the static and dynamic characteristics of CMOS inverter.
5. Implement Full Adder using transmission gate, Pseudo NMOS technology.
6. Design and implement EX-OR gate using CMOS, Pseudo-NMOS, Dynamic and Domino logic styles.

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## WIRELESS AND MOBILE COMMUNICATIONS LAB (PCL-2)
## (Common to DECE, WMC)

**Prerequisites: -**

**Course Objectives**:
1. To analyze Cellular concepts, GSM and CDMA networks.
2. Analyze the digital carrier modulation and demodulation techniques.
3. To describe GSM handset by experimentation and fault insertion techniques.
4. Analyze CDMA concept using DSSS kit.

**Experiments:**
**Note:** Experiments 1 to 5 need to be simulated using Matlab and tested on hardware**.**

1. FSK Modulation and Demodulation technique.
2. QPSK Modulation and Demodulation technique.
3. DQPSK Modulation and Demodulation technique
4. 8-QAM Modulation and Demodulation technique.
5. Implementation of Convolutional Encoder and Decoder.
6. Simulation of the following Outdoor Path loss propagation models using MATLAB.
   a. Free Space Propagation model b. Okumura model c. Hata model
7. Simulation of Adaptive Linear Equalizer using MATLAB software.
8. Measurement of call blocking probability for GSM &CDMA networks using Netsim software.
9. Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
10. Study of transmitter and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.
11. Simulation of RAKE Receiver for CDMA communication using MATLAB software.

12. Simulate and test various types of PN codes, chip rate, spreading factor and processing gain on performance of DSSS in CDMA.

13. Simulate and test the 3G Network system features using GSM AT Commands. (Features of 3G Communication system: Transmission of voice, video calls, SMS, MMS, TCP/IP, HTTP, GPS).

14. Modelling of communication system using Simulink.

**Online Resources:**

1. http://onlinecources.nptel.ac.in/noc18_ee29 (Introduction to wireless cellular communications by Prof.David Koilpillai, IIT M)
2. http://onlinecources.nptel.ac.in/noc18_ee21 (Principles of signal Estimation for MIMO/OFDM wireless communications by Prof.Aditya.K Jagannadham, IITK)

**Course Outcomes**: At the end of this course, students will be able to

1. Implement the advanced digital modulation techniques**.**
2. Design Convolutional encoder and decoder for error control coding techniques.
3. Calculate path loss for Free space, Okumura and Hata models for outdoor propagation.
4. Comprehend Cellular concepts of GSM and CDMA networks.
5. Simulate RAKE receiver for CDMA with MATLAB.
6. Analyze GSM architecture.

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**RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (PW)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites: -**

**Course Objectives:**
1. To develop an understanding of IPR/ research methodology in the process of creation of patents through research.
2. To develop further research capabilities.

**UNIT 1:** (~7 Lecture Hours)
**Research Methodology:** Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research.

**UNIT 2:** (~6 Lecture Hours)
**Research Design:** Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes, Data collection methods, Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data.

**UNIT 3:** (~6 Lecture Hours)
**Research Report Writing:** Format of the Research report, Synopsis, Dissertation, References/Bibliography/Webliography, Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

**UNIT 4:** (~6 Lecture Hours)
**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

**UNIT 5:** (~10 Lecture Hours)
**Patent Rights:** Scope of Patent Rights, Licensing and transfer of technology. Patent information and databases. New Developments in IPR: Administration of Patent System.

**Text Books:**

1. C.R Kothari, "Research Methodology, Methods & Technique". New Age International Publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.

3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
4. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.
5. Satarkar, S.V,.“Intellectual property rights and copy right”. ESS Publications, 2000.

**Reference Books:**

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners, 2012.
2. Halbert, “Resisting Intellectual Property”, Taylor& Francis Ltd, 2007.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc18 ge12

**Course Outcomes:** At the end of this course, students will be able to

1. Describe research problem formulation
2. Analyze research related information
3. Follow research ethics.
4. Understand the new developments in Intellectual Property Right
5. Develop patent grants
6. Create new and better products, and in turn brings about, economic growth and social benefits

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**MICROCONTROLLERS AND PROGRAMMABLE DIGITAL SIGNAL PROCESSORS (PC-3)**

**Prerequisites:** 1**.** Microprocessors and Microcontrollers 2. Digital Signal Processing

**Course Objectives:**
1. Understand the internal architecture of ARM Cortex M3,
2. Provide basics of Exceptions and Interrupts,
3. Impart knowledge of Programmable DSP (P-DSP) Processors
4. Familiarize the internal architecture of TMS320C6000 series.

**UNIT 1:** (~ 12 Lecture Hours)
**ARM Cortex-M3 processor:** Applications, Programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence Instruction Set, Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces.

**UNIT 2:** (~ 7 Lecture Hours)
**Exceptions:** Exceptions, Types, Priority, Vector Tables, Interrupt Inputs and Pending behavior, Fault Exceptions, Supervisor and dependable Service Call,

**UNIT 3:** (~ 8 Lecture Hours)
**Interrupts**: Nested Vectored Interrupt Controller, Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.

**UNIT 4**: (~ 8 Lecture Hours)
**Programmable DSP (P-DSP) Processors:** Harvard Architecture, Multi-port memory, architectural structure of P-DSP- MAC unit, Barrel shifters, Introduction to TI DSP processor family.

**UNIT 5:** (~ 10 Lecture Hours)
**VLIW architecture and TMS320C6000 series:** Architecture study, data paths, cross paths, Introduction to Instruction level architecture of C6000 family, Assembly Instructions memory addressing, for arithmetic, logical operations. Code Composer Studio for application development for Digital signal processing, On chip peripherals, Processor benchmarking**.**

**Text Books:**

1. Joseph Yiu, "The definitive guide to ARM Cortex-M3", Elsevier, 2nd Edition, 2011.
2. Venkatramani B. and Bhaskar M. "Digital Signal Processors: Architecture, Programming and Applications" , TMH , 2nd Edition, 2002.

3. Sloss Andrew N, Symes Dominic, Wright Chris, “ARM System Developer's Guide: Designing and Optimizing”, Morgan Kaufman Publication 2nd Edition, 2004.

**Reference Books:**

1. Steve Furber, “ARM System-on-Chip Architecture”, Pearson Education 2nd Edition 2001.
2. Frank Vahid, Tony Givargis, “Embedded System Design A Unified Hardware Software Introduction”, John Wiley India, Edition-Student edition, 2014.

**Online Resources:**

1. http://nptel.ac.in/courses/108102045/8
2. http://nptel.ac.in/courses/117106111/
3. Technical reference manuals from www.arm.com, www.ti.com

**Course Outcomes:** At the end of this course students will be able to

1. Compare ARM processor core based SoC with several features/peripherals based on requirements of embedded applications.
2. Identify and characterize architecture of Programmable DSP Processors
3. Visualize the role of Real time Operating Systems in Embedded Systems.
4. Instantiate with Exceptions, Interrupts and Timer operations performed inside the processors.
5. Design and practice small applications by utilizing the ARM processor core.
6. Develop small applications by utilizing the DSP processor based platform.

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## ADVANCED COMMUNICATION NETWORKS (PC-4)

**Prerequisites:** Computer Networks

**Course Objectives:**

1. Communication networking concepts.
2. Real time protocols in communication networking.
3. Quality of Service and network design.

**UNIT 1:** (~ 7 Lecture Hours)
**Network Models:** Layered Tasks, The OSI Model, Layers in OSI Model, TCP/IP Protocol suite, Addressing.
**Network Layer Protocols**: Internet Protocol (IP), Classful and Classless addressing, ICMPv4, Mobile IP, Concepts of Routing Protocols.
**Next Generation IP**: IPv6, Addressing IPv6 Protocol, ICMPV6 Protocol, Transition from IPV4 to IPV6

**UNIT 2:** (~ 10 Lecture Hours )
**Transmission Control Protocol**: TCP Services, TCP Features, Segments, TCP Connection, State Transition Diagram, Windows in TCP, Flow and Error Control ,TCP Congestion Control, TCP Timers, TCP Over Ad Hoc Wireless Networks, Other transport layer protocols for Ad-Hoc Wireless Networks.
**User Datagram Protocol:** User Datagram, UDP Services, UDP Applications
**Stream Control Transmission Protocol (SCTP):** Services, Features, Packet Format, Flow Control, Error Control, Congestion Control.

**UNIT 3**: (~ 8 Lecture Hours )
**Congestion Control and Quality of Service:** Data Traffic, Congestion, Congestion Control, Quality of Service, Techniques to Improve QoS,
**ATM**: Design Goals, ATM Architecture, Switching, Switch Fabric, ATM Layers, Service Classes, ATM Application.
**SONET/SDH**: Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks.

**UNIT 4** (~ 10 Lecture Hours )
**Quality of Service in Ad Hoc Wireless Networks:** Introduction, Real Time Traffic Support in Ad Hoc Wireless Networks, QoS Parameters in Ad Hoc Wireless Network, Issues and Challenges in providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions: MAC Layer Solutions, Cluster TDMA, IEEE 802.11e, DBASE, Network Layer Solutions, QoS Routing Protocols, Ticket Based QoS Routing Protocol, Predictive Location Based QoS routing protocol, Trigger Based Distributed QoS Routing Protocol, QoS enabled AODV Routing Protocol, Bandwidth QoS Routing Protocol, On Demand QoS Routing Protocol, On Demand

Link-State Multipath QoS Routing Protocol, Asynchronous Slot Allocation Strategies. QoS Frameworks for Ad Hoc Wireless Networks.

**UNIT 5** ( ~ 10 Lecture Hours )
**Integrated Services:**Real Time Communications over Internet, Adaptive applications, Latency and throughput issues. Integrated Services Model (intServ), Resource reservation in Internet. RSVP.
**Admission control in Internet:** Concept of Effective bandwidth. Measurement based admission control, Differentiated Services in Internet (DiffServ), DiffServ architecture and framework.

**Text Books:**

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top Down Approach" 6th Edition, Pearson Publications, 2013.
2. William Stallings, "High Speed Networks and Internets", 2nd Edition, TMH , 2010
3. B. S. Manoj and C. Shiva Ram Murthy, "Ad Hoc Wireless Networks Architecture and Protocols", 1st Edition, PHI, 2004.

**Reference Books :**

1. S. Keshav, "An Engineering Approach to Computer Networking: ATM Networks, the Internet and the Telephone Networks", 3rd Edition, Pearson Publications, 2005.
2. B. A.Forouzan, "Data Communications and Networking", 5th Edition, TMH, 2013.
3. Larry L. Peterson & Bruce S. Davie, "Computer Networks: A System Approach", 3rd Edition, Morgan Kaufmann Publishers, 2003.
4. George Kesidis, "ATM Network Performance", 2nd Edition, Kluwer Academic Research Papers, 2005.
5. Zhang Wang, "Internet QoS", 1st Edition, Morgan Kaufman Publishers, 2001.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc18_cs38/preview: Sowmya K. Ghosh & Sandip Chakraborthy
2. www.coursera.org.

**Course Outcomes:** At the end of this course, students will be able to

1. Understand the concepts of TCP/IP and Network Parameters.
2. Illustrate Internet Protocol concepts.
3. Explain the concepts of UDP and SCTP.
4. Familiarize to the architectures of ATM and SONET.
5. Measure the Quality of Service in Internet & Ad Hoc Wireless Networks.
6. Examine the Integrated Services Model, Resource reservation in Internet.

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## EMBEDDED SYSTEMS DESIGN (PE-3)

**Prerequisites: 1.** Microprocessors and Microcontrollers, 2. Computer Organization and Operating Systems

**Course Objectives:**

1. Discuss the major components that constitute an embedded system.
2. Implement small programs to solve well-defined problems on an embedded platform.
3. Develop familiarity with tools used to develop in an embedded environment.
4. Design, describe, validate and optimize embedded electronic systems in different industrial application areas.

**UNIT 1:** (~ 10 Lecture Hours)
**Introduction to Embedded Systems:** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

**UNIT 2**: (~ 12 Lecture Hours)
**Typical Embedded System:**
Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

**UNIT 3:** (~ 8 Lecture Hours)
**Embedded Firmware:** Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

**UNIT 4:** (~ 8 Lecture Hours)
**Embedded Communication Protocols:**
Embedded Networking: Introduction –Serial/Parallel communication-Serial communication Protocols–RS 232 standard – RS485 – synchronous serial protocols – serial peripheral interface (SPI) , Inter integrated Circuit (I2C)-PC Parallel port Programming – ISA/PCI Bus protocols – Firewire.

**UNIT 5:** (~ 10 Lecture Hours)

**Wireless Embedded Networking:**

Wireless Sensor networks – Introduction, applications – Network Topology – Localization – Time Synchronization – Energy efficient MAC protocols – SMAC – Energy efficient and robust rooting – Data centric routing.

**Text Books:**

1. Shibu K.V,"Introduction to Embedded Systems", Mc Graw Hill 2nd Ed. 2016.
2. Jan Axelson,"Parallel Port Complete: Programming, Interfacing & Using the PC's Parallel Printer Port", Penram Publications, 1996.

**Reference Books :**

1. Frank Vahid, Tony Givargis, "Embedded System Design A Unified Hardware Software Introduction", John Wiley India, Edition-Student edition, 2014.
2. Bhaskar Krishnamachari, "Networking Wireless Sensors", Cambridge Press, 2005.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc18_cs05/preview
2. http://nptel.ac.in/courses/108102045/
3. https://www.tutorialspoint.com/embedded_systems/index.htm

**Course Outcomes:** At the end of this course, students will be able to

1. Explain the basic characteristics of general computing systems and embedded systems.
2. Describe the Core of the Embedded System with peripherals.
3. Compare and distinguish memories, general purpose processors and domain specific purpose processors.
4. Learn the method of designing an Embedded System for any type of applications.
5. Understand various Embedded Network Protocols.
6. Demonstrate the conceptual frame work of wireless sensor network and their design requirements.

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## LOW POWER VLSI DESIGN (PE-3)

**Prerequisites:** VLSI Technology and Design

**Course Objectives:**
1. To develop CMOS digital circuits for a low voltage low power environment.
2. To acquire the knowledge on the concepts of device behavior and modelling.
3. To understand the concepts of low voltage, low power circuits.
4. To design low power memory and microprocessor systems.

**UNIT 1:** (~ 9 Lecture Hours)
**Technology & Circuit Design Levels**: Sources of power dissipation in digital ICs, degree of freedom, recurring themes in low-power, emerging low power approaches, dynamic dissipation in CMOS, effects of $V_{dd}$ and Threshold voltage on speed, constraints on Threshold voltage reduction, transistor sizing & optimal gate oxide thickness, impact of technology scaling, technology innovations.

**UNIT 2:** (~ 9 Lecture Hours)
**Low Power Circuit Techniques**: Power consumption in circuits, flip-flops & latches, high capacitance nodes, energy recovery, reversible pipelines, high performance approaches.

**UNIT 3:** (~ 9 Lecture Hours)
**Low Power Clock Distribution**: Power dissipation in clock distribution, single driver versus distributed buffers, buffers & device sizing under process variations, zero skew Vs tolerable skew, chip & package co-design of clock network.

**UNIT 4:** (~ 10 Lecture Hours)
**Logic Synthesis for Low Power estimation techniques**: Power minimization techniques, Low power arithmetic components- circuit design styles, adders, multipliers.
**Low Power Memory Design**: Sources & reduction of power dissipation in memory Subsystem, sources of power dissipation in DRAM & SRAM, low power DRAM circuits, low power SRAM circuits.

**UNIT 5:** (~ 8 Lecture Hours)
**Low Power Microprocessor Design System**: Power management support, architectural trade offs for power, choosing the supply voltage, low-power clocking, implementation problem for low power, comparison of microprocessors for power & performance.

**Text Books :**

1. Rabaey, Jan M., Pedram, Massoud, "Low Power Design Methodologies" Springer US Publisher, 1996.
2. Kaushik Roy, Sharat Prasad, "Low power CMOS VLSI circuit design", John Wiley sons Inc., 2000.

**Reference Books:**

1. P. Rashinkar, Paterson and L. Singh, "Low Power Design Methodologies", Kluwer Academic, 2002
2. J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley, 1999.
3. A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design", Kluwer, 1995.
4. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.

**Online Resources**

1. http://nptel.ac.in/courses/106105161/58
2. https://www.researchgate.net
3. http://nptel.ac.in/courses/106105034

**Course Outcomes:** At the end of this course, students will be able to

1. Identify various sources of power dissipation in digital IC systems
2. Realise the impact of power on system performance and reliability.
3. Acquire Knowledge about different Low power estimation Techniques.
4. Familiarize on various leakage sources and reduction techniques
5. Estimate power dissipation in clock distribution
6. Design and develop low power Memory and Microprocessor systems

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## DESIGN OF FAULT TOLERANT SYSTEMS (PE-3)

**Prerequisites:** Digital System Design

**Course Objectives:**

1. To understand need for testing of manufactured ICs and the testing terminology.
2. To understand the concepts involved in making ICs Fault Tolerant and Self Checking
3. To build digital circuits which are easily testable.

**UNIT 1:** (~8 Lecture Hours)

**Concepts of Reliability:** Reliability, Failures & Faults, Reliability and Failure Rate, Relation between Reliability and Mean Time Between Failure, Maintainability and Availability, Reliability of Series, Parallel and Parallel-Series Combinational Circuits.

**Fault Tolerant Design:** Basic Concepts, Static, Dynamic, Hybrid, Triple Modular Redundant System (TMR), 5MR Reconfiguration Techniques, Fault Tolerant Design of Memory Systems, Time Redundancy and Software Redundancy.

**UNIT 2:** (~8 Lecture Hours)

**Self Checking Circuits & Fail Safe Design:** Self Checking Circuits: Basic Concepts of Self Checking Circuits, Design of Totally Self Checking Checker, Checkers for m out of n Codes, Berger Code and Low Cost Residue Code.

**Fail Safe Design:** Strongly Fault Secure Circuits, Fail Safe Design of Sequential Circuits using Partition Theory and Berger Code, Totally Self Checking PLA Design.

**UNIT 3:** (~12 Lecture Hours)

**Design for Testability:** Need for Testing, Fault Models – Stuck At Faults, Transistor Faults, Bridging Faults, Fault Simulation – Serial, Parallel, Concurrent and Deductive Fault Simulation, Test Generation Basics, Controllability and Observability, SCOAP, Fault – Oriented Test Generation.

**Design for Testability by means of scan:** Making circuits Testable, Testability Insertion, Full Scan DFT Techniques- Full Scan Insertion, Flip-Flop Structures, Full Scan Design and Test, Scan Architectures–Full Scan Design, Shadow Register DFT, Partial Scan Methods, Multiple Scan Design, Other Scan Designs, RT Level Scan Design – RTL Design Full Scan, RTL Design Multiple Scan, Scan Designs for RTL.

**UNIT 4:** (~10 Lecture Hours)

**Logic Built-in-self-test:** BIST Basics–Memory Based BIST,BIST Effectiveness, BIST Types, Designing a BIST, Test Pattern Generation - Engaging TPGs, Exhaustive Counters, Ring Counters, Twisted Ring Counter, Linear Feedback Shift Register, Output Response Analysis-Engaging ORA's, One's Counter, Transition Counter,

Parity Checking, Serial LFSRs, Parallel Signature Analysis, BIST Architectures-BIST Related Terminologies, Centralized and Separate Board-Level BIST Architecture, Built-in Evaluation and Self Test(BEST), Random Test Socket(RTS), LSSD On-chip Self Test, Self Testing using MISR and SRSG, Concurrent BIST, BILBO, Enhancing Coverage, RT Level BIST Design -CUT Design, Simulation and Synthesis, RTS BIST Insertion, Configuring the RTS BIST, Incorporating Configurations in BIST, Design of STUMPS, RTS and STUMPS Results.

**UNIT 5:** (~8 Lecture Hours)
**Standard IEEE Test Access Methods:** Boundary Scan Basics, Boundary Scan Architecture– Test Access port, Boundary Scan Registers, TAP Controller, Decoder Unit, Select and Other Units, Boundary Scan Test Instructions-Mandatory Instructions, Board Level Scan Chain Structure - One Serial Scan Chain, Multiple Scan Chain with One Control Test Port, Multiple Scan Chains with One TDI,TDO but Multiple TMS, Multiple-Scan Chain & Multiple Access Port, RT Level Boundary Scan- Inserting Boundary Scan Test Hardware for CUT, Two Module Test Case, Virtual Boundary Scan Tester, Boundary Scan Description Language.

**Text Books:**


1. Parag K. Lala, "Fault Tolerant & Fault Testable Hardware Design", PHI, 1985.
2. Zainalabedin Navabi, "Digital System Test and Testable Design using HDL models and Architectures", Springer International Edition, 2014.


**Reference Books:**


1. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, "Digital Systems Testing andTestable Design", JaicoPublishing House, 2006.
2. Bushnell M&Vishwani D. Agarwal, "Essentials of Electronic Testing", Springer, 2004.
3. Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, "VLSI Test Principles and Architectures: Design for Testability", Morgan Kaufmann, 2006.


**Online Resources:**

1. https://chipedge.com
2. https://onlinecourses.nptel.ac.in/noc

**Course Outcomes:** At the end of this course, students will be able to

1. Explain the concepts of faults and fault tolerant systems.
2. Demonstrate different approaches to build Fault Tolerant and Self Checking Circuits.
3. Recognize the need for fault models, controllability and observability in generation of test vectors for testing digital systems.
4. Design different architectures for Chip Level DFT Techniques.
5. Illustrate different architectures for System Level DFT Techniques.
6. Incorporate the different DFT architectures into digital designs using RTL code.

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## DIGITAL IMAGE & VIDEO PROCESSING (PE-4)
## (Common to DECE, WMC)

**Prerequisites:** Digital Signal Processing

**Course Objectives:**
1. Provide fundamentals of Digital Image Processing.
2. Give the students a taste of applications of the theories taught in the subject.
3. Introduce few advanced topics in Image and Video Processing.
4. Give the students a useful skill base in the area of Image & Video Processing that creates interest in related applications.

**UNIT 1:** (~ 8 Lecture Hours)
**Fundamentals of Image Processing:** Fundamentals steps in Digital Image Processing, Image Sampling & Quantization, Basic relationships between Pixels.
**Image Transforms:** Introduction to DFT, DCT, Walsh Transform, Hadamard Transform, Haar Transform & Wavelet Transform – Basics of CWT & DWT.

**UNIT 2:** (~ 10 Lecture Hours)
**Image Enhancement:** Basic gray level transformations, Histogram processing, Basics of Spatial filtering, Smoothening Spatial filters, Sharpening Spatial filters, Filtering in frequency domain, Smoothening frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

**UNIT 3:** (~ 12 Lecture Hours)
**Image Restoration:** Model of Image degradation/restoration process, Periodic noise reduction by Frequency domain filtering, Linear position Invariant degradations, Estimating the Degradation function, Inverse filtering, Minimum mean square error filtering.
**Color Image Processing:** Color fundamentals, Color models, Pseudo color Image Processing, Basics of full Color Image Processing.

**UNIT 4:** (~ 6 Lecture Hours)
**Introduction to Video Processing:** Digital Video, Sampled Video, Time varying Image formation models – Three-dimensional motion models, Geometric Image formation, Photometric Image formation, Sampling of Video signals, Filtering operations.

**UNIT 5:** (~ 10 Lecture Hours)
**Image Compression:** Lossless Coding – Introduction, Basics of Lossless Image Coding, Lossless Symbol Coding, Lossless Coding standards, Fundamentals of Vector Quantization – Introduction, Theory of Vector Quantization, Design of Vector

quantizers, VQ implementations, JPEG Lossy Image Compression – Introduction, Lossy JPEG Codec structure (Encoder & Decoder).
**Video Compression:** Introduction to Video Compression, Video compression application requirements, Video Compression techniques – Entropy & Predictive coding, Block transform coding, Discrete Cosine Transform, Quantization, Motion compensation & estimation, Video Encoding Standards and H.261.

**Text Books :**


1. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", 3rd Edition, Pearson.
2. Al Bovik, "Handbook of Image and Video Processing", Academic Press.
3. Yao Wang, JoemOstermann and Ya–quin Zhang, "Video Processing and Communications", 1st Edition, PHI.


**Reference Books:**


1. A Murat Tekalp, "Digital Video Processing", Pearson, 2010.
2. A K Jain, Fundamentals of Digital Image Processing", PHI, 1989.
3. S Jayaraman, S Esakkirajan, T Veerakumar, "Digital Image Processing", TMH, 2010.
4. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing using MATLAB", 2nd Edition, McGraw Hill Education, 2010


**Online Resources:**

1. https://www.cse.iitb.ac.in/~ajitvr/CS663_Fall2015/
2. http://www.satishkashyap.com/2013/07/video-lectures-on-digital-image.html

**Course Outcomes:** At the end of this course, students will be able to

1. Analyze various advanced Image transforms.
2. Understand different techniques employed for the Enhancement of images both in Spatial & Frequency domain.
3. Explore image degradation and various restoration techniques.
4. Study the concepts of Colour Image Processing.
5. Demonstrate the basic concepts in Video Processing.
6. Compare the various Image and Video Compression Techniques.

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**MACHINE LEARNING (PE-4)**
**(Common to DECE, CNIS)**

**Prerequisites: -**

**Course Objectives**

1. To be able to formulate machine learning problems corresponding to different applications.
2. To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on advances
3. To explore supervised, unsupervised, rule based and reinforcement learning paradigms of machine learning.

**UNIT 1:** (~ 8 Lecture Hours)
**Introduction:** Well posed learning problems, Designing a learning system, Perspectives and issues in machine learning. Types of Learning: Supervised, unsupervised and reinforcement learning.
**Concept Learning:** Concept learning task, Concept Learning as search through a hypothesis space. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm, remarks on them. Inductive Bias.

**UNIT 2:** (~ 10 Lecture Hours)
**Decision Tree Learning**: – Decision Tree representation and learning algorithm, Appropriate problems for Decision Tree Learning, Hypothesis space search in Decision Tree learning, Inductive bias in Decision Tree learning: Occam's razor. Issues in Decision Tree learning. Learning with active queries.
**Bayesian Learning:** Bayes theorem and concept learning, Maximum Likelihood and least square error Hypothesis, Minimum Description Length Principle, Bayes optimal classifier, Gibbs Algorithm, NaiveBayes Classifier, Bayesian Belief Networks, The EM algorithm.

**UNIT 3:** (~ 8 Lecture Hours)
**Computational Learning Theory:** PAC Hypothesis, Sample complexity for finite and infinite hypothesis spaces, Mistake bound model.
**Instance-based Techniques**: Lazy vs. eager generalisation. K nearest neighbour Learning, Locally Weighted Regression, Radial Basis Functions,Case Based Reasoning.

**UNIT 4:** (~ 12 Lecture Hours)
**Evaluation of Learning Algorithms:** Estimating Hypothesis accuracy, Basics of sampling theory, General approach for deriving confidence intervals. Difference in error of two hypotheses. Comparing learning algorithms.
**Learning by Rules:** Learning sets of rules: Sequential covering algorithms, Learning rule sets: summary, Learning first order rules, FOIL.

Analytical Learning: Learning with perfect domain theories: Prolog-EBG. Remarks on Explanation Based Learning,

**UNIT 5:** (~ 10 Lecture Hours)
**Combining Inductive and Analytical Learning**: Inductive analytical approaches to learning, Using prior knowledge - Initialize the hypothesis, Alter search objective, Augment search operators.
**Reinforcement Learning:**
Introduction, The Learning Task, Q-Learning, Non deterministic rewards and actions, Temporal difference Learning, Generalizing from examples, Relationship to dynamic programming

**Text Books**

1. Tom M. Mitchell, Machine Learning. Mc Graw Hill Education. 1997

**Reference Books**

1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani& Jerome Friedman. "The Elements of Statistical Learning", Springer Series in Statistics, 2nd Edition 2001
3. William W Hsieh "Machine Learning Methods in the Environmental Sciences, Neural Networks and Kernels", Cambridge University Press.
4. Stephen Marsland, "Machine Learning - An Algorithmic Perspective ", CRC Press, 2009.

**Online Resources:**

1. http://www.cs.cmu.edu/~tom/
2. http://www.holehouse.org/mlclass/

**Course outcomes:** At the end of this course, students will be able to

1. Student should be able to identify machine learning problems corresponding to different applications.
2. Ability to recognize the basic theory underlying machine learning.
3. Ability to identify machine learning techniques appropriate to respective problems.
4. To compare range of machine learning algorithms along with their strengths and weaknesses.
5. To recognize the underlying mathematics and logic behind various machine learning algorithms under supervised and unsupervised paradigms.
6. Apply variety of learning algorithms to solve problems of moderate complexity.

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## WIRELESS SENSOR NETWORKS (PE-4)
## (Common to DECE, WMC)

**Prerequisites:** 1. Computer Networks 2.Wireless Communication Networks.

**Course Objectives:**
1. To analyze various sensor nodes, sensor network programming.
2. To get acquaintance with medium access control protocols and address physical layer issues.
3. To inculcate key routing and transport layer protocols for sensor networks and main design issues.
4. To provide analysis of the power management aspects, time synchronization, localization and security issues.

**UNIT 1:** (~ 10 Lecture Hours)
**Introduction:** Components of a wireless sensor node, Motivation for a Network of Wireless Sensor Nodes, Classification of sensor networks, Characteristics of wireless sensor networks, Challenges of wireless sensor networks, Comparison between wireless sensor networks and wireless mesh networks, Limitations in wireless sensor networks, Design challenges, Hardware architecture, Applications.
**Node Architecture:** The Sensing Subsystem, the Processor Subsystem, Communication Interfaces, Prototypes.
**Operating Systems (Tiny OS):** Functional and Non-functional Aspects, Prototypes, Evaluation.

**UNIT 2:** (~ 10 Lecture Hours)
**Popular sensor nodes**-The "Mica Mote" family, EYES nodes, BT nodes, Scatter web, Commercial solutions
**Sensor Network Programming:** Challenges in sensor network programming, Node-Centric programming, Microprogramming, dynamic reprogramming, Sensor network simulators.
**Basic Architectural Framework:** Physical Layer, Basic Components, Source Encoding, Channel Encoding, Modulation

**UNIT 3:** (~ 9 Lecture Hours)
**Medium Access Control**: Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols.
**Network Layer:** Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols.

**UNIT 4**: (~ 8 Lecture Hours)
**Node and Network Management:** Power Management, Local Power Management aspects, Dynamic Power Management, Conceptual Architecture.

**Time Synchronization:** Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols.

**UNIT 5**: (~ 8 Lecture Hours)
**Localization:** Ranging Techniques, Range-Based Localization, Range-Free Localization, Event- Driven Localization.
**Security:** Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and Zig Bee Security.

**Text Books**

1. WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley 2010.
2. Mohammad S. Obaidat, SudipMisra, "Principles of Wireless Sensor Networks", Cambridge, 2014.
3. Holger Karl, Andreas Willig, "Protocols and Architectures for wireless sensor networks" Wiley, 2005.

**Reference Books:**

1. Carlos de Morais Cordeiro & Dharma prakash Agarwal," Adhoc& wireless sensor, 2nd edition, World Scientific & Imperial college press,2006.
2. Sunil Kumar, S.Manvi, Mahabalaseshwar, "wireless & sensor mobile networks concepts and protocols" Wiley ,2010
3. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley, 2010.
4. C.S. Raghavendra, K.M. Sivalingam, TaiebZnati, "Wireless Sensor Networks", Springer, 2010
5. C. Sivarmmurthy& B.S. Manoj, "Adhoc Wireless Networks",1st Edition, PHI,2004.
6. Fei Hu., Xiaojun Cao, "Wireless Sensor Networks",1st Edition, CRC Press, 2013.

**Online Resources:**

1. http://onlinecources.nptel.ac.in/noc18_cs38 (Computer Networks and internet protocol, Prof.Soumya kannato Ghosh & Prof. Sandip Chakraborty, IIT Kharapur)
2. http://onlinecources.nptel.ac.in/noc18_ee29 (Introduction to wireless cellular communications by Prof.David Koilpillai, IITM).

**Course Outcomes:** At the end of this course, students will be able to

1. Analyze various issues in sensor networks.
2. Identify various sensor platforms and supporting protocols.
3. Acquaint with various sensor network simulators and sensor network programming.
4. Identify different operating systems for the implementation and deployment of wireless sensor networks.
5. Design MAC, routing and transport protocols for wireless sensor networks.
6. Comprehend Security mechanisms attacks sensor network.

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**MICROCONTROLLERS AND PROGRAMMABLE DIGITAL SIGNAL PROCESSORS LAB (PCL -3)**

**Course Objectives:**

1. Compare the features of ARM Cortex M3 and DSP C6713.
2. Experiment with the programming of ARM Cortex M3 and DSP C6713.
3. Utilize the instruction set of ARM Cortex M3
4. Interpret the instruction set of DSP C6713.

**Part A) Experiments to be carried out on Cortex-M3 development boards and using GNU tool chain.**

**Code Development for Part A:**

1. Blink an LED with software delay, delay generated using the SysTick timer.
2. Using the PLL modules with System clock real time alteration.
3. Control intensity of an LED using PWM implemented in software and hardware.
4. Control an LED using switch by polling method, by interrupt method and flash the LED once every five switch presses.
5. UART Echo Test.
6. To take analog readings on rotation of rotary potentiometer connected to an ADC channel.
7. For Temperature indication on an RGB LED.
8. To Mimic light intensity sensed by the light sensor by varying the blinking rate of an LED.
9. To Evaluate the various sleep modes by putting core in sleep and deep sleep modes.
10. System reset using watchdog timer in case something goes wrong.
11. To Sample sound using a microphone and display sound levels on LEDs.

**Part B) Experiments to be carried out on DSP C6713 evaluation kits and using Code Composer Studio (CCS)**

1. To develop and implement in assembly code and C code to compute Euclidian distance between any two points.
2. To develop and implement in assembly code and study the impact of parallel, serial and mixed execution.
3. To develop and implement in assembly and C code for implementation of convolution operation.
4. To design and implement filters in C to enhance the features of given input sequence/signal.

**Note:Minimum of 12 experiments to be conducted (Minimum of 2 from Part B)**

**Online Resources:**

1. http://nptel.ac.in/courses/108102045/8
2. http://nptel.ac.in/courses/117106111/
3. Technical reference manuals from www.arm.com, www.ti.com

**Course Outcomes:** At the end of this course students will be able to

1. Infer the instruction set of Cortex M3.
2. Interpret the instruction set of TI C6713 DSP Processor.
3. Build and configure tool sets for developing applications based on ARM processor core and DSP processor.
4. Develop prototype codes using commonly available on and off chip peripherals on the Cortex M3.
5. Develop prototype codes using commonly available on and off chip peripherals on the DSP development boards.
6. Use standard test and measurement equipment to evaluate analog/digital interfaces

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## ADVANCED COMMUNICATION NETWORKS LAB (PCL -4)

**Course Objectives:**

1. Networking commands.
2. Linux network configuration.
3. TCP/IP client server concepts.

**List of Experiments:**

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration
   a) Configuring NIC's IP Address.
   b) Determining IP Address and MAC Address using if-config command.
   c) Changing IP Address using if-config.
   d) Static IP Address and Configuration by Editing.
   e) Determining IP Address using DHCP.
   f) Configuring Hostname in /etc/hosts file.
3. Design TCP iterative Client and Server application to reverse the given input sentence.
4. Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call "select".
5. Design UDP Client Server to transfer a file.
6. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.
   a) Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterize traffic when the DNS server is up and when it is down.
7. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.
8. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterize file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.
9. Signaling and QoS of labeled paths using RSVP in MPLS.
10. Find shortest paths through provider network for RSVP and BGP
11. Understand configuration, forwarding tables, and debugging of MPLS.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc18_cs38/preview: Sowmya K. Ghosh & Sandip Chakraborthy
2. www.coursera.org.

**Course Outcomes:** At the end of this course, students will be able to

1. Identify the different types of network devices and their functions within a network.
2. Learn the skills of sub-netting and routing mechanisms.
3. Design the TCP/IP, UDP client- server applications.
4. Configure the Application Layer protocols.
5. Understand network implementation.

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## MIMO SYSTEMS (PE-5)
## (Common to DECE, WMC)

**Prerequisites:** Detection and Estimation Theory

**Course Objectives:**
1. To understand basic requirement of MIMO systems.
2. To develop channel modeling for MIMO.
3. To calculate capacity of wireless channels.
4. To study multiplexing capabilities and architectures of MIMO channel.

**UNIT 1:** (~ 9 Lecture Hours)
**Point-to-Point Communication: Detection, Diversity and Channel Uncertainty** Detection in a Rayleigh fading channel – non coherent detection coherent detection, from BPSK to QPSK: exploiting the degrees of freedom, diversity. Time diversity – repetition coding, beyond repetition coding, time diversity in GSM. Antenna diversity – receiver diversity, transmit diversity: space-time codes, MIMO: a 2 × 2 example. Frequency diversity – basic concept, single-carrier with ISI equalization, direct sequence spread spectrum, orthogonal frequency division multiplexing.

**UNIT 2:** (~ 9 Lecture Hours)
**Capacity of Wireless Channels** AWGN channel capacity - repetition coding, packing spheres, Capacity. Resources of the AWGN channel - continuous-time AWGN channel, power and bandwidth, bandwidth reuse in cellular systems. Linear time-invariant Gaussian channels, single input multiple output (SIMO) channel, multiple input single output (MISO) channel, frequency-selective channel. Capacity of fading channels – slow fading channel, receive diversity, transmit diversity, time and frequency diversity, fast fading channel, transmitter side information, frequency-selective fading channels.

**UNIT 3:** (~ 9 Lecture Hours)
**Spatial Multiplexing and Channel Modeling** Multiplexing capability of deterministic MIMO channels – capacity via singular value decomposition, rank and condition number. Physical modeling of MIMO channels, line-of-sight SIMO channel, line-of-sight MISO channel, antenna arrays with only a line-of-sight path, geographically separated antennas, line-of-sight plus one reflected path. Modeling of MIMO fading channels – Basic approach, MIMO multipath channel, angular domain representation of signals, angular domain representation of MIMO channels, statistical modeling in the angular domain, degrees of freedom and diversity, dependency on antenna spacing, IID Rayleigh fading model.

**UNIT 4:** (~ 9 Lecture Hours)
**Capacity and Multiplexing Architectures:** The V-BLAST architecture.Fast fading MIMO channel – capacity with CSI at receiver, performance gains, full CSI. Receiver

architectures – linear decorrelator, successive cancellation, linear MMSE receiver, information theoretic optimality. Slow fading MIMO channel. D-BLAST: an outage-optimal architecture – Sub-optimality of V-BLAST, coding across transmit antennas: D-BLAST.

**UNIT 5:** (~ 9 Lecture Hours)
**Multiuser Communication:** Uplink with multiple receive antennas – space-division multiple access, SDMA capacity region, system implications, slow fading, fast fading, multiuser diversity revisited. MIMO uplink – SDMA with multiple transmit antennas, system implications, fast fading. Downlink with multiple transmit antennas, degrees of freedom in the downlink, upink-downlink duality and transmit beamforming, precoding for interference known at transmitter, precoding for the downlink, fast fading. MIMO Downlink

**Text Books:**
1. David Tse Pramod Viswanath, "Fundamentals of Wireless Communication", 1st edition, Cambridge University Press, 2014.
2. Mohinder Janakiraman, "Space - Time Codes and MIMO Systems", Artech House Publishers, 2004.

**Reference Books:**
1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010.
2. Togla M. Duman, Ali Ghrayeb, "Coding for MIMO Communication Systems", John Wiley & Sons Ltd, 2007.
3. Hamid Jafarkhani, "Space Time coding –Theory and Practice", Cambridge university press, 2005.

**Online Resource:**
1. http://nptel.ac.in/courses/117105132/

**Course Outcomes**: At the end of this course, students will be able to
1. Perform Mathematical modeling of a MIMO systems.
2. Analyze the performance of different diversity techniques.
3. Derive channel capacity of a MIMO system.
4. Apply the Space-Time coding in MIMO system.
5. Comprehend multi-user communication in MIMO.
6. Identify the appropriate multiplexing architecture for the given environment.

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## REAL TIME OPERATING SYSTEMS (PE-5)

**Prerequisites:** 1.Operating Systems 2. Embedded Systems

**Course Objectives:**

1. Real time scheduling theory concept.
2. Experience on real time scheduler implementation applied to real time systems
3. Skills necessary to develop software for embedded computer systems using a real-time operating system.
4. Basic knowledge of RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.

**UNIT 1:** (~ 12 Lecture Hours)
**Introduction**: Introduction to UNIX/LINUX, Overview of Commands, File I/O,(open, create, close, lseek, read, write), Process Control ( fork, vfork, exit, wait, waitpid, exec).

**UNIT 2:** (~ 10 Lecture Hours)
**Real Time Operating Systems**: Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use

**UNIT 3:** (~ 8 Lecture Hours)
**Objects, Services and I/O**: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem

**UNIT 4:** (~ 8 Lecture Hours)
**Exceptions, Interrupts and Timers:** Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

**UNIT 5:** (~ 10 Lecture Hours)
**Case Studies** of RTOS: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.

**Text Books :**


1. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011
2. Embedded Real Time Systems: Concepts, Design Programming, Black book, Dreamtech Press 1st Ed 2003.

**Reference Books :**


1. W. Richard Stevens, Stephan A. Rago, "Advanced UNIX Programming", Pearson, 2nd Edition, 2006.
2. Dr. Craig Hollabaugh, "Embedded Linux: Hardware, Software and Interfacing", Pearson, 1st Edition, 2008.
3. Introduction to Embedded Systems - Shibu K.V, McGraw Hill, 2nd Ed. 2016.


**Online Resources:**

1. https://www.slideshare.net/pantechsolutions/rtos-basic-concepts
2. https://onlinecourses.nptel.ac.in/noc18_cs12/preview
3. http://nptel.ac.in/courses/106105036/28

**Course Outcomes:** At the end of this course students will be able to

1. Explain the concepts of UNIX operating systems.
2. Contrast Concepts of real time operating systems with GPOS.
3. Define Objects services and IO subsystems
4. Instantiating with Exceptions, Interrupts and Timer operations built in RTOS.
5. Compare various Real Time OS.
6. Illustrate case study of RT Linux, uC/OS-II, Vx Works, Embedded Linux.

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## INTERNET OF THINGS AND APPLICATIONS (PE-5)

**Prerequisites:** 1. Embedded Systems 2. Real Time Operating Systems

**Course Objectives:**

1. Understand the Internet of Things (IoT) which aims at enabling the interconnection and integration of the physical world and the cyber space.
2. Represent the trend of future networking, and leads the third wave of the IT industry revolution.
3. Exposed to wide application areas of IoT.
4. Design challenges and key scientific problems involved in IoT development.

**UNIT 1:** (~ 12 Lecture Hours)
**IoT& Web Technology:** The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.

**UNIT 2:** (~ 10 Lecture Hours)
**IoT Architecture:** State of the Art – Introduction, State of the art, Architecture Reference Model Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View.

**UNIT 3:** (~ 8 Lecture Hours)
**M2M to IoT:** A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

**UNIT 4:** (~ 8 Lecture Hours)
**IoT Applications:** for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

**UNIT 5:** (~ 10 Lecture Hours)
**Internet of Things Privacy, Security and Governance:** Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a

Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.

**Text Books :**

1. Cuno Pfister, "Getting Started with the Internet of Things", OReilly Media, 2011.
2. Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.

**Reference Books:**

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2013.
2. Francis DaCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.

**Online Resources:**

1. https://www.tutorialspoint.com/internet_of_things/index.htm
2. https://onlinecourses.nptel.ac.in/noc17_cs22/preview
3. https://onlinecourses.nptel.ac.in/noc17_ee20/preview

**Course Outcomes:** At the end of this course students will be able to

1. Explain concepts of IoT and Web technology.
2. Familiarize to the architecture features of M2M to IoT.
3. Illustrate architecture of IoT.
4. Classify various application areas of IoT.
5. Learn IoT model architecture
6. Examine Privacy and Security constraints of IoT based applications.

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## BUSINESS ANALYTICS (OE)

**Prerequisites:** -

**Course Objectives:**

1. To understand the role of business analytics within an organization.
2. To gain an understanding in usage of business analytics in formulating and solving problems using analytical and management tools in managerial decision making.
3. To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization and across various sectors.

**UNIT 1 :** ( ~9 Lecture Hours)

**Introduction to Business Analytics**

Introduction to Business Analytics Overview of Business Analytics Evolution of Business Analytics, classification of Business Analytics, Trends of Business Analytics, frame work of Business Analytics, Data for Business Analytics, Decision models, Problem solving & decision making. Business analytics process and organization. Competitive and advantages.

**UNIT 2 :** ( ~8 Lecture Hours)

**Statistics for Business Analytics**

Organization structure of Business Analytics; Team management issues, designing information policy, outsourcing, ensuing data quality, Introduction to Data mining Descriptive Analytic tools – Statistical notation. Data Summarization methods.

**UNIT 3 :** ( ~9 Lecture Hours)

**Descriptive Tools**

Descriptive Statistical Tools – Tables, graphs, charts, histograms, frequency distribution, relative frequency. Measures of central tendency & dispersion. Introduction to Probability theory & distributions (Binomial, Poisson & Normal) Sampling & estimation methods.

**UNIT 4**: ( ~10 Lecture Hours)

**Forecasting Techniques**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting models, Forecasting Models for stationary Time series. Forecasting Models for Time series with a linear trend, Forecasting Time series for seasonality, Regression Forecasting with casual variables, selecting Appropriate Forecasting Models.Monte Carlo simulation and Risk Analysis:Monte Carlo simulation using Analytic solver platform, Newsvendor Model, Overbooking Model.

**UNIT 5** : ( ~12 Lecture Hours)

**Decision Analysis**

Decision Analysis: Formulating Decision problems, Decision strategies, Decision trees, value of information utility & decision making, data story telling & Data Journalism, Recent Trends in: Embedded & collaborative business intelligence. Data warehousing & Data mining.

**Text Books:**

1. Business Analytics for Managers: Taking Business Intelligence Beyond Reporting – wiley Publication: GertH.N.Laursen, JesperThorlund, Wiley Pub 2nd Edition.
2. Business Analytics: Data Analysis & Decision Making, Al bright/Winston, Cengage Learning Publications, 5th Edition.

**Reference Books:**

1. Business analytics Principles, Concepts, and Applications by Marc I. Schniederjans, Dara G. Schniederjans, Christopher M. Sarkey, Pearson FT Press, 1st Edition.
2. Business Analytics by James Evans, Pearsons Education, 2nd Edition.

**Online Resources:**

1. NPTEL: Business Analytics for Management Decision http://nptel.ac.in/courses/110105089/

**Course Outcomes:** At the end of this course students will be able to

1. Knowledge of data analytics.
2. Think critically in making decisions based on data analytics.
3. Identify the befitting descriptive tool required for the business problem.
4. Identify appropriate prescriptive modeling technique for decision making.
5. Apply suitable predicative method that supports business decision making.
6. Translate data into clear, actionable insights in the decision making process

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**INDUSTRIAL SAFETY (OE)**

**Prerequisites:** -

**Course Objectives:**

1. Concepts of industrial safety and provide useful knowledge for work place safety.
2. Helps in identification, evaluation and control of the hazards.
3. Mitigate harm to people, property and the environment.

**UNIT 1**: (~10 Lecture Hours)
Industrial safety-Importance and objectives of safety, safety programs – components and realisation. Evolution of modern safety concept, safety policy, safety organisation. implementation of safety procedures-periodic inspection and replacement.

**UNIT 2:** (~8 Lecture Hours)
Accidents causes, types, results and control, mechanical and electrical hazards types, causes and preventive steps , describe salient points and factories act 1948 for health and safety ,wash rooms, drinking water layout, lights, cleanliness fire guarding etc. safety colour code, fire prevention and fire fighting equipments and methods.

**UNIT 3:** (~10 Lecture Hours)
Fundamentals of maintenance engineering. Definition aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, types of maintenance, types of applications of tools used for maintenance, maintenance cost and its relations with replacement economy, service life of equipment.

**UNIT 4:** (~9 Lecture Hours)
Quality and safety in maintenance: needs for quality maintenance process, maintenance work quality, use of quality control, charts in maintenance work sampling, post maintenance testing, reasons for safety problems in maintenance, guidelines to safety in maintenance work, safety officers' role in maintenance work, Protection of maintenance workers.

**UNIT 5:** (~8 Lecture Hours)
Periodic and preventive maintenance:- Periodic inspection – concept and need, degreasing, cleaning and repairing schemes, over hauling of mechanical components, overhauling of electrical motors, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance.

**Text Books:-**

1. 2. Krishnan N.N. Safety management in industries, Jaico publishing house, Bombay, 1997.
2. H.P. Garg, S., Maintenance Engineering, S. Chand and company.

**Reference Books :**

1. Handley,W. Industrial safety Hand book, 2nd Edn, McGraw-Hill Book Company, 1969
2. Higgins & Morrow ,Maintenance Engineering Handbook, , Da Information Services.
3. Mc Cornick, E.J., Human Factors in Engineering and design, Tata McGraw-Hill, 1982.

**Online Resources:**

1. https://www.spplimited.co.in/industrial-safety-certificate-course-training-in-chennai/
2. https://onlinecourses.nptel.ac.in/noc18_mg42/preview

**Course Outcomes: :** At the end of this course students will be able to

1. Know the need for safety in industries.
2. Know about factory acts and industrial safety regulations.
3. Analyse causes and types of different hazards on their preventions.
4. Assess quality maintenance processes and maintenance work quality.
5. Assess safety practices and programs.
6. Know about periodic and preventive maintenance activities in industries

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**OPERATIONS RESEARCH (OE)**

**Prerequisites:** -

**Course objectives:**

1. Study the linear programming and non linear programming techniques used for business and engineering applications.
2. Understand the importance of dynamic programming concept in operations research
3. Know about the inventory, Game theory and waiting line model applications in real world.

**UNIT 1**: ( ~10 Lecture Hours)

**Introduction to Operations Researc**h: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem-Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M methods, Special cases in LP-Degeneracy, unbounded, infeasibility & alternative optima.

**UNIT 2:** ( ~8 Lecture Hours)

**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions-Northwest corner rule, least cost method and Vogel's approximation method.Optimality test by MODI method & stepping stone method.

**Assignment problem**: Formulation. Hungarian method for optimal solution.Solving unbalanced Assignment problem.

**UNIT 3 :** ( ~8 Lecture Hours)

**Non-linear Programming**: Introduction to non-linear programming (NLP), Convex and concave functions, NLP with one variable, Line search algorithms, Multivariable unconstrained problems, constrained problems, Lagrange Multiplier, The Karush-Kuhn-Tucker (KKT) conditions, the method of steepest ascent, convex combination method, penalty function, Quadratic programming

**UNIT 4:** (~8 Lecture Hours)

a) **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Coach/Shortest Path and cargo loading problems.
b) **Inventory models**. Inventory costs. Models with deterministic demand-model (a) demand rate uniform and production rate infinite, model (b) demand rate uniform and production rate finite.

**UNIT 5:** ( ~10 Lecture Hours)

a) **Games Theory**. Competitive games rectangular game saddle point, minimax (maximin) method of optimal strategies, and value of the game. Solution of games

with saddle points, dominance principle. Rectangular games without saddle point-mixed strategy for 2*2 games.
b) **Waiting lines:** Single channel –poison arrivals and exponential service times with infinite population and finite population models. Multi channel- poisson arrivals and exponential service times with infinite population

**Text Books:**

1. J K Sharma., Operations Research, theory and applications, 5th edition, Macmillan India Ltd ,2013
2. S S Rao, Engineering optimisation – Theory and Practice, 4th Edition, John Wiley & Sons Inc., 2009 .

**Reference Books:**

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. F.H. Hillier and G.J. Lieberman, Introduction to Operations Research, Tata-McGraw-Hill, 2010
3. S.D. Sharma, Operations Research, Kedarnnath, Ramnath & Co., Meerut, 2009.
4. V.K. Kapoor, Operations Research", S. Chand Publishers, New Delhi, 2004.

**Online Resources:**

1. Online websites / Materials: IOR Tutorials(Interactive Operations Research Tutorial)
2. Online Courses: onlinecourses.nptel.ac.in

**Course outcomes :** At the end of this course students will be able to

1. Apply linear programming models to several Engineering Applications.
2. Able to apply the concept of non linear programming.
3. In Dynamic Programming selected models were taught.
4. Apply simple mathematical models in Inventory into the real Engineering Applications.
5. Solve Game theory problems related to business applications,
6. To minimize waiting time of the customer and optimization of number of servers.

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## COST MANAGEMENT OF ENGINEERING PROJECTS (OE)

**Prerequisites:** -

**Course Objectives:**

1. Give inputs in handling the cost associated with engineering projects.
2. Acquaint the practical aspects of cost management.
3. Orient the quantitative techniques applicable to cost management.

**UNIT 1 :** ( ~10 Lecture Hours)
**Cost Management -** Introduction and importance of Cost Management, Cost Classification on the basis of behaviour (as variable, fixed and semi variable), traceability (as direct and indirect), functions (as production cost, administration cost, selling cost and distribution cost), Various cost concepts. Objectives of costing system, Traditional Costing system, Activity Based Costing (ABC), and Cost Audit.

**UNIT 2 :** ( ~7 Lecture Hours)
**Project Management –** Project Planning, Types of Project, Stages of Project execution importance of PERT and CPM, Project crashing – Problems.

**UNIT 3 :** ( ~10 Lecture Hours)
**Budgetary Control –**Introduction to Budget, Concepts advantages, types of Functional budgets: Fixed and Flexible budget, Performance budget, Cash Budget and Production Budget. Introduction to Zero based budgeting, (Simple Problems on Functional based budget).

**UNIT 4 :** ( ~10 Lecture Hours)
**Inventory Management -** Valuing the Inventory using LIFO, FIFO and Weighted Average Methods, Economic Order Quantity (EOQ), Just-in-time, Material Requirements Planning (MRP), ABC Analysis, VED Analysis and Value Chain Analysis.

**UNIT 5 :** ( ~10 Lecture Hours)
**Costing for Managerial Decision Making -** Factors governing pricing policy, objectives of Pricing policy, concept of transfer pricing, objectives and methods. Choosing the right Pricing method with simple problems.International Transfer Pricing. Relevant costing for make or buy and evaluation of special order.

**Text Books:**

1. Cost Accounting: A Managerial Emphasis, Charles T. Horngren and George Foster, PHI, 1st edition.

2. Management Accounting, Anthony A.Atkinson, Robert S Kalpan et al., Pearson, 6th edition
3. Quantitative Techniques in Management, N. D. Vohra, Tata Mc. Graw Hill, 4th edition.

**Reference Books:**

1. Cost Management: A Strategic Emphasis by Blocher, Chen, Cokins, and Lin.
2. Strategic Cost Management by John K. Shank and Vijay Govindarajan.

**Online Resources:**
**NPTEL**

1. Managerial Accounting: http://nptel.ac.in/courses/110101004/24

**Course Outcomes:** At the end of this course students will be able to

1. Perceive the cost associated in managing engineering projects
2. Prepare budgets for engineering projects.
3. Enumerate and effectively handle the inventory management in reducing the project management cost.
4. Envelope the cost associated in price fixation of the projects.
5. Orient the cost management decision-making using quantitative methodology in minimizing the cost associated with the projects.
6. Furnish effective cost management practices for better handling of engineering projects

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## COMPOSITE MATERIALS (OE)

**Prerequisites: -**

**Course Objectives:**

1. Learn to demonstrate a critical understanding of composite materials of their nature and application
2. Critically evaluate the types of reinforcements and their advantages in application.
3. Develop an understanding of different types of metal matrix composites and their preparation.
4. Develop an understanding of different types of ceramic matrix composites and their preparation.
5. Develop an understanding of different types of polymer matrix composites and their preparation.
6. Critically evaluate strength of the composite materials through Laminar study.

**UNIT 1:** ( ~9 Lecture Hours)

**INTRODUCTION:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT 2:** ( ~9 Lecture Hours)

**REINFORCEMENTS:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT3:** ( ~9 Lecture Hours)

**Manufacturing of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT 4:** ( ~8 Lecture Hours)

**Manufacturing of Polymer Matrix Composites**: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT 5:** ( ~9 Lecture Hours)
**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro-thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**Text Books:**

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, WestGermany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

**Reference Books:**

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa,and Stephen W.

**Online Resources:**

1. http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Composite%20Materials/pdf/Lecture_Notes/LNm1.pdf
2. https://www.asminternational.org/documents/10192/1849770/05287G_Sample_Chapter.pdf
3. http://home.iitk.ac.in/~mohite/Composite_introduction.pdf
4. https://onlinecourses.nptel.ac.in/noc18_me03/preview
5. https://www.online.colostate.edu/courses/MECH/MECH530.dot

**Course Outcomes:** At the end of this course students will be able to

1. Students will learn different composite materials and their applications
2. Students will have capacity to integrate knowledge and to analyse, evaluate and manage the different the types of reinforcements.
3. Develop different types of metal matrix composites and prepare the same for their specific needs as engineers.
4. Develop different types of ceramic matrix composites and prepare the same for their specific needs as engineers.
5. Develop different types of polymer matrix composites and prepare the same for their specific needs as engineers.
6. Critically enhance strength of the composite materials through Laminar usage.

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**ENERGY FROM WASTE (OE)**

**Prerequisites: -**

**Course Objectives:**

1. To classify various waste resources.
2. To identify various methods of waste disposal.
3. To study various energy generation methods from waste.
4. To analyze various processes of recycling of waste and environmental benefits.
5. To know the significance of managing of waste.

**UNIT 1:** ( ~8 Lecture Hours)
Introduction: Classification of waste as fuel – Agro based, Forestresidue, Industrial waste - MSW, recycling of municipal waste , Segregation of waste , Managing waste , Medical waste /Pharmaceutical waste treatment , Environmental impacts.
Solid waste: Land fill method of Solid waste disposal, Land fill classification, Types.

**UNIT 2:** ( ~10 Lecture Hours)
Biomass: Pyrolysis – Types, Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT 3:** ( ~8 Lecture Hours)
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT 4:** ( ~8 Lecture Hours)
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes.
Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**UNIT 5:** ( ~8 Lecture Hours)
E-waste: e-waste in the global context- Environmental concerns and health hazards Recycling e-waste, Global trade in hazardous waste, e-waste legislation, Government regulations on e-waste management.

**Text Books:**


1. Desai, Ashok V., "Non Conventional Energy" Wiley Eastern Ltd., 1990.
2. Khandelwal, K.C. and Mahdi S.S. "Biogas Technology-A Practical Hand Book Vol.I& II," Tata McGraw Hill Publishing Co.Ltd.' 1983.
3. Challal,D.S., " Food, Feed and Fuel from Biomass" IBH Publishing Co.Pvt.Ltd.,1991.
4. Nicholas P.Cheremisinoff."Handbook of Solid Waste Management and Waste Minimization Technologies" An Imprint of Elsevier, New Delhi , 2003.


**Reference Books:**


1. C.Y.WereKo-Brobby and E.B.Hagan," Biomass Conversion and Technology" John Wiley & Sons,1996.
2. M.Dutta,B.P.Parida,B.K.Guha and T.R.Surkrishnan " Industrial Solid Waste Management and Landfilling practice."Narosa Publishing House, New Delhi, 1999.
3. P.AarneVesilind,WilliamA.Worrell and Debra R.Reinhart, " Solid Waste Engineering" Thomson Asia Pte Ltd. Singapore (2002)


**Course Outcomes:** At the end of this course students will be able to
1. Understand the methods of recycling of waste.
2. Compare the methods of waste disposal.
3. Identify different sources of energy from waste.
4. Analyze methods for management of waste.
5. Understand the global trade in hazardous waste.

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## POWER FROM RENEWABLE ENERGY SOURCES (OE)

**Prerequisites: -**

**Course Objectives:**

1. To introduce various types of renewable energy technologies
2. To understand the technologies of energy conversion from the resources and their quantitative analysis

**UNIT 1:** ( ~10 Lecture Hours)
Fundamentals of Solar Energy-Solar spectrum- Solar Radiation on Earth's surface-Solar radiation geometry-Solar radiation measurements- Solar radiation data- Solar radiation on horizontal and tilted surfaces. Solar Thermal conversion- Flat plate collectors- concentrated collectors- construction and thermal analysis- Solar applications- Solar ponds- Heliostat systems-water heater-air heater-solar still

**UNIT 2:** ( ~8 Lecture Hours)
Solar-Electric Power generation- Photovoltaic cells- Equivalent circuit- V-I Characteristics- Photovoltaic modules – constructional details- design considerations- Tracking- Maximum power point tracking - Solar Thermo electric conversion.

**UNIT 3:** ( ~8 Lecture Hours)
Wind Energy- Fundamentals of wind energy-power available in wind- Betz Limit Aerodynamics of wind turbine- Wind turbines- Horizontal and vertical axis turbines –their configurations- Wind Energy conversion systems

**UNIT 4:** ( ~9 Lecture Hours)
Energy from Bio Mass- Various fuels- Sources-Conversion technologies-Wet Processes – Dry Processes- Bio Gas generation – Aerobic and anaerobic digestion - Factors affecting generation of bio gas - Classification of bio gas plants-Different Indian digesters- Digester design considerations - Gasification process - Gasifiers – Applications. Geothermal Energy - sources- Hydrothermal convective - Geo-pressure resources - Petro-thermal systems (HDR) - Magma Resources-Prime Movers.

**UNIT 5:** ( ~9 Lecture Hours)
Ocean Thermal Energy Conversion Systems- Principle of operation - Open and closed cycles, Energy from Tides - Principle of Tidal Power - Components of tidal Power plants - Operation Methods - Estimation of Energy in Single and double basin systems - Energy and Power from Waves Wave energy conversion devices - Fuel Cells - Design and Principle of operation - Types of Fuel Cells - Types of Electrodes – Applications - Basics of Batteries - Constructional details of Lead acid batteries - Ni-Cd Batteries.

**Text Books:**

1. "John Twidell & Wier", "Renewable Energy Resources", CRC Press, 2009
2. "G. D. Rai", "Non Conventional Energy sources", Khanna publishers, 2004

**Reference Books:**

1. "D. P .Kothari, Singal, Rakesh and Ranjan", "Renewable Energy sources and Emerging Technologies", PHI, 2009.
2. "F. C. Treble", Generating Electricity from Sun, Pergamon Press, 1st Edition 1991
3. C. S. Solanki, "Solar Photovoltaics - Fundamentals- Principles and Applications", PHI, 2009
4. "S. P. Sukhatme", "Solar Energy Principles and Application", TMH, 2009.

**Course Outcomes:** At the end of this course students will be able to

1. Analyse solar thermal and photovoltaic systems and related technologies for energy conversion
2. Understand Wind energy conversion and devices available for it
3. Understand Biomass conversion technologies, Geo thermal resources and energy conversion principles and technologies
4. Realize Power from oceans (thermal, wave, tidal) and conversion devices
5. Understand fundamentals of fuel cells and commercial batteries.

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**ENGLISH FOR RESEARCH PAPER WRITING (AC-1)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites: -**

**Course Objectives:**

1. To understand the nuances of language and vocabulary in writing a Research Paper
2. To develop the content, structure and format of writing a research paper
3. To give the practice of writinga Research Paper
4. To enable the students to evolve original research papers without subjected to palgiarism

**UNIT 1 :** ( ~7 Lecture Hours)
**Academic Writing**
What is Research? - Meaning & Definition of a research paper?– Purpose of a research paper – Scope – Benefits – Limitations – outcomes.

**UNIT 2** : ( ~7 Lecture Hours)
**Research Format**
Title – Abstract – Introduction – Discussion - Findings – Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

**UNIT 3:** ( ~6 Lecture Hours)
**Research Methodology**
Methods (Qualitative – Quantitative) – Literature Review – Who did what – Criticizing, Paraphrasing & Plagiarism.

**UNIT 4 :** ( ~6 Lecture Hours)
**Process of Writing a research paper**
Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - Typing the final draft

**UNIT 5 :** ( ~6 Lecture Hours)
**How to & where to get published**
Reputed Journals – National/International – ISSN No, No. of volumes, Scopes Index/UGC Journals – Free publications - Paid Journal publications – /Advantages/Benefits

**Text Books:**

1. MLA Hand book for writers of Research Papers, East West PressPv1t. Ltd, New Delhi, 7thEdn,

2. C. R Kothari, Gaurav, Garg, Research Methodology Methods and Techniques New Age International Publishers. 4th Edn.
3. Lauri Rozakis, Schaum's Quick Guide to Writing Great Research Papers, Tata McGraw Hills Pvt. Ltd, New Delhi.
4. N. Gurumani, Scientific Thesis Writing and Paper Presentation, MJP Publishers

**Course Outcomes:** At the end of this course students will be able to

1. The student will be able to understand the nuances of research writing
2. The student will be able to write a research paper with required writing skills and be confident to share their writing with others
3. The student will be able to publish a paper using the requisite standard in a journal
4. The student will be able to review the research papers and articles in a scientific manner.
5. The student will be able to work on citations and ably place them in her research paper.
6. The student will be able to avoid plagiarism and be able to develop her own writing skills in presenting the research work.

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## DISASTER MANAGEMENT (AC-1)
## (Common to PEED, DECE, CSE, CNIS, WMC)

**Prerequisites:** Awareness about Various Planetary & Extra Planetary Hazards, their Impacts & Mitigation measures

**Course Objectives:**

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.
5. Students will get the overview on the roles of government and non-government agencies in disaster management.
6. Describe the basic concepts of the emergency management cycle (mitigation, preparedness, response and recovery) and their application on various types of disasters.

**UNIT 1 :** ( ~8 Lecture Hours)
**Introduction and Repercussions of Disasters and Hazards:** Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts. .

**UNIT 2 :** ( ~5 Lecture Hours)
**Disaster Prone Areas in India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with special reference to Tsunami; Post-Disaster Diseases and Epidemics.

**UNIT 3 :** ( ~5 Lecture Hours)
**Disaster Preparedness and Management Preparedness**: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT 4** : ( ~5 Lecture Hours)
**Risk Assessment Disaster Risk**: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation In Risk Assessment, Strategies for Survival.

**UNIT 5 :** ( ~5 Lecture Hours)
**Disaster Mitigation:** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation - Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

**Text Books:**


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


**Reference Books:**


1. Disaster Management Guidelines. GOI-UNDP Disaster Risk Reduction Programme (2009-2012).
2. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
3. Satapathy S. (2009) Psychosocial care in Disaster management, A training of trainers manual (ToT), NIDM publication.
4. Guerisse P. 2005 Basic Principles of Disaster Medical Management. Act Anaesth. Belg;56:395-401
5. Aim and Scope of Disaster Management. Study Guide prepared by Sharman and Hansen. UW-DMC, University of Washington.


**Online Resources:**

1. https://www.mooc-list.com/tags/earthquake
2. https://freevideolectures.com/course/3581/earthquakes-in-your-backyard
3. https://summer.uci.edu/online/
4. http://www.open.edu/openlearn/free-courses/full-catalogue
5. https://www.edx.org
6. https://www.disasterready.org/courses

**Course Outcomes:** At the end of this course students will be able to

1. Students will learn different disasters and measures to reduce the risk due to these disasters.
2. Students will learn institutional frame work for disaster management at national as well as global level.
3. Capacity to integrate knowledge and to analyze, evaluate and manage the different public health aspects of disaster events at a local and global levels, even when limited information is available.
4. Capacity to describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.

5. Students will understand the emergency/disaster management cycle for various types of disasters.
6. Develop a basic understanding of prevention, mitigation, preparedness, response and recovery on various types of disasters.

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**PEDAGOGY STUDIES (AC-1)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites:** -

**Course Objectives:**

1. To understand the programme design and policies of pedagogy studies.
2. To develop knowledge, abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. Analyze various theories of learning and their connection to teaching practice.
4. To familiarize the student with various research designs and research methods.
5. To create an awareness about the practices followed by DfID, other agencies and other researchers.
6. To identify critical evidence gaps to guide the development.

**UNIT 1 :** (~08 Lecture Hours)
**Introduction and Methodology:**

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

**UNIT 2 :** (~06 Lecture Hours )

- Thematic overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

**UNIT 3 :** (~06 Lecture Hours)

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

**UNIT 4 :** (~06 Lecture Hours)

- Professional development: alignment with classroom practices and follow up support.
- Support from the head teacher and the community.

- Curriculum and assessment.
- Barriers to learning: Limited resources and large class sizes.

**UNIT 5 :** (~06 Lecture Hours)

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

**Text Books:**


1. Ackers J, Hardman F (2001) Classroom Interaction in Kenyan Primary Schools, Compare, 31 (2): 245 – 261.
2. Agarwal M (2004) Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) : 361 – 379.
3. AkyeampongK,(2003) Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER) Country Report 1.London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282.
5. Alexander R J (2001) Culture and Pedagogy : International Comparisons in Primary Education.Oxford and Boston : Blackwell.
6. Chavan M (2003) Read India: A mass scale,rapid, 'learning to read' campaign.


**Online Resources:**

www.pratham.org/images/resources%20working%20paper%202.pdf.

**Course Outcome:** At the end of this course students will be able to

1. The pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. To examine the effectiveness of pedagogical practices.
3. To understand the concept, characteristics and types of educational research and perspectives of research.
4. The role of teacher education, school curriculum and guidance materials for effective pedagogy.

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**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (AC-1)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites:** -

**Course Objectives:**

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.

**UNIT 1 :** ( ~5 Lecture Hours)

- Neetisatakam – Holistic development of personality.
- Verses 19,20,21,22 (Wisdom)
- Verses 29,31,32 (Pride and Heroism)
- Verses 26,28,63,65 (Virtue)

**UNIT 2 :** ( ~5 Lecture Hours)

- Neetisatakam – Holistic development of personality (cont'd)
- Verses 52,53,59 (dont's)
- Verses 71,73,75 & 78 (do's)
- Approach to day to day works and duties.

**UNIT 3 :** ( ~5 Lecture Hours)

- Introduction to Bhagavadgeetha for Personality Development
- Shrimad BhagawadGeeta: Chapter 2 – Verses 41, 47, 48
- Chapter 3 – Verses 13,21,27,35
- Chapter 6 – Verses 5,13,17,23,35
- Chapter 18 – Verses 45, 46, 48

**UNIT 4 :** ( ~5 lecture hours)

- Statements of basic knowledge
- Shrimad BhagawadGeeta: Chapter 2- Verses 56, 62,68
- Chapter 12 – Verses 13, 14, 15, 16, 17, 18
- Personality of Role model from Shrimad BhagawatGeeta.

**UNIT 5 :** ( ~5 Lecture Hours)

- Role of Bahgavadgeeta in the present scenario
- Chapter 2 – Verses 17
- Chapter 3 – Verses 36, 37, 42
- Chapter 4 – Verses 18, 38, 39
- Chapter 18 – Verses 37, 38, 63.

**Text Books:**

1. Srimad Bhagavad Gita by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2. Bhartrihari'sThriSatakam (Niti – Sringar- Vairagya) by P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

**Course Outcome:** At the end of this course students will be able to

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Develop versatile personality.

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**SANSKRIT FOR TECHNICAL KNOWLEDGE (AC-2)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites:** -

**Course Objectives:**

1. To get a working knowledge in Illustrious SANSKRIT, the scientific language in the world.
2. To improve brain functioning.
3. To enhance the memory power to develop logic in Mathematics, Science and other subjects.
4. To explore the huge treasure of knowledge that is hidden in the ancient literature.

**UNIT 1 :** ( ~6 Lecture Hours)
**Alphabets in SANSKRIT**
Varnamala–Vowels (Swaraaha) and consonants (Vyanjanaani) – samyuktavarnaaha (compound letters) – Varna vishleshanam (Disjoining of letters) – Varna samshleshanam(Joining of letters) - Practise of simple words – Three genders – Pumlingam (MasculineGender) – Streelingam (FeminineGender) – Napumsaka lingam (Neutral Gender) – The forms of Nouns – Singular & Plural

**UNIT 2 :** ( ~6 Lecture Hours)
Pronouns & Demonstrative pronouns (Sarvanaamashabdaaha) Eshaha, Yeshaa&Yetat–Question words – Five Ws & one H (Kim, kadaa, kutra, Kaha, Kimartham&Katham) Different forms of verbs – Tenses – Present – Past & Future Tenses

**UNIT 3 :** ( ~6 Lecture Hours)
Propositions (Vibhaktis) – Prathama – Dwitiya – Truteeya – Chaturthee – Panchami – Shashtee – Saptami – Sambodhana Prathama
The Three Purushas – Prathama (RamahaRaamouRaamaaha) – Madhyama (twamYuvaamYooyam) – Uttama(AhamAawaamVayam)

**UNIT 4 :** ( ~6 Lecture Hours)
Order (Subject – Verb – Object) karta – Kriya - karma
Introduction of Roots – Ancient literature on Science & Technology in SANSKRIT language - Scope of SANSKRIT in India – Technical information about SANSKRIT Literature.- Technical concepts of Engineering.

**UNIT 5 :** ( ~6 Lecture Hours)

Technical concepts of Engineering – Electrical, Mechanical, Architecture and Mathematics - Role of SANSKRIT in the field of Science & Technology. Scope of SANSKRIT as a powerful & alternative tool in the field of Computer Science.

**Suggested Reading:**


1. "ABHYAAS PUSTAKAM", Dr. Vishwas, SamskruthaBharati Publications, New Delhi.
2. Teach Yourself SANSKRIT, Prathama Deeksha by VempatiKutumbaShastri, Rashtriya Sanskrit Sansthan, NewDelhi Publications.
3. "India's glorious Scientific Tradition", Suresh Soni, Ocean Books Pvt. Ltd., NewDelhi.


**Course Outcomes:** At the end of this course students will be able to

1. Gain knowledge in basic SANSKRIT language.
2. Understand the ancient SANSKRIT literature about Science & Technology.
3. Develop logical and analytical skills.

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**VALUE EDUCATION (AC-2)**

**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites:** -

**Course Objectives:**

1. Understand value of Education and self-development.
2. Imbibe good values in students
3. Know the importance of character

**UNIT 1 :** ( ~5 Lecture Hours)

- Values and self – development – Social values and Individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non – moral Valuation. Standards and principles.
- Value judgements
- Importance of cultivation of values.

**UNIT 2 :** ( ~6 Lecture Hours)

- Sense of duty, Devotion, Self – reliance. Confidence, Concentration, Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism, Love for nature, Discipline

**UNIT 3 :** ( ~5 Lecture Hours)

- Personality and Behaviour Development – Soul and Scientific attitude. Positive thinking. Integrity and Discipline.
- Punctuality, Love and Kindness.
- Avoid Fault Thinking.
- Free from anger, Dignity of labour

**UNIT 4 :** ( ~5 Lecture Hours)

- Universal brotherhood and religious tolerance.
- True friendship
- Happiness Vs suffering, love for truth.
- Aware of self - destructive habits.
- Association and Cooperation.
- Doing best for saving nature.

**UNIT 5 :** ( ~6 Lecture Hours)

- Character and Competence – Holy books Vs Blind faith.
- Self-management and Good Health.
- Science of Reincarnation.
- Equality, Nonviolence, Humility, Role of Women.

- All religions and same message.
- Mind your Mind, Self- control.
- Honesty, Studying effectively

**Text Books:**

1. Chakroborty, SK. 'Values and Ethics for Organizations – Theory and Practise', - Oxford University Press, NewDelhi.

**Course Outcome:** At the end of this course students will be able to

1. Gain knowledge on self-development.
2. Learn the importance of Human Values
3. Develop overall personality

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**CONSTITUTION OF INDIA (AC-2)**
**(Common to PEED, DECE, CSE, CNIS, WMC)**

**Prerequisites:** -

**Course Objectives:**

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**UNIT 1** : ( ~8 Lecture Hours)
**History of making of the Indian Constitution & Philosophy of the Indian Constitution**
***History of making of the Indian Constitution***: History, Drafting Committee (Composition & Working)
***Philosophy of the Indian Constitution***: Preamble, Salient Features.

**UNIT 2 :** ( ~6 Lecture Hours)
**Contours of Constitutional Rights and Duties**
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT 3 :** ( ~6 Lecture Hours)
**Organs of Governance:**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions- Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT 4 :** ( ~6 Lecture Hours)
**Local Administration**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayati Raj : Introduction, PRI : ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Position and role, Block Level : Organizational Hierarchy (Different departments), Village level : Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT 5 :** ( ~6 Lecture Hours)

**Election Commission**

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

**Suggested Reading:**


1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr.S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edition, Lexis Nexis, 2014.


**Course Outcome:**

1. Get the clarity and idea about function of Indian constitution.
   Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies
2. Grab the knowledge of union government & their powers and function.
3. Understand state and central policies, fundamental duties
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies
5. Understand Electoral Process, special provisions

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**(AUTONOMOUS)**
**Shaikpet, Hyderabad– 500104**
**DIGITAL ELECTRONICS AND COMMUNICATION ENGINEERING (Under ECE)**

**M.Tech. I Year, II Sem.** **L T P C**
**2 - - -**

**STRESS MANAGEMENT BY YOGA (AC-2)**
**(Common to PEED,DECE,CSE,CNIS,WMC)**

**Prerequisites:** -

**Course Objectives:**

1. Creating awareness about different types of Stress and role of Yoga in the management of Stress.
2. Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3. Prevention of stress related health problems by Yoga practice.

**UNIT 1 :** ( ~4 Lecture Hours)
- Meaning and definition of Yoga
- Historical perspective of Yoga
- Principles of Astanga Yoga by Patanjali.

**UNIT 2 :** ( ~4 Lecture Hours)
- Meaning and definition of Stress.
- Types of Stress-Eustress and Distress.
- Anticipatory Anxiety and Intense Anxiety and depression.
- Meaning of Management- Stress Management.

**UNIT 3 :** ( ~8 Lecture Hours)
- Concept of Stress according to Yoga
- Stress assessment methods
- Role of Asana, Pranayama and Meditation in the management of stress.

**UNIT 4 :** ( ~8 Lecture Hours)
Asanas:: ( 5 Asanas in ach posture)
- Warm up
- Standing Asanas
- Sitting Asanas
- Prone Asanas
- Supine asanas
- Surya Namaskar

**UNIT 5 :** ( ~8 Lecture Hours)
**Pranayama:**
- Anulom and Vilom Pranayama
- Nadishudhi Pranayama
- Kapalabhati Pranayama

- BhramariPranayama
- Nadanusandhana Pranayama.

**Meditation techniques:**

- Om Meditation
- Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique ( QRT), Deep Relaxation Technique ( DRT)

**Text Books:**


1. Andrews, Linda Washer (2005) Stress control for peace of mind, London: Greenwich Editions.
2. Author's Guide -Yoga- The science of Holistic Living, Chennai: The Vivekananda Kendra Prakashan trust.
3. Iyengar BKS (2003) The art of Yoga, New Delhi: Harper Collins Publishers.
4. Lalvani, Vimla ((1998)Yoga for Stress, London: Hamlyn.
5. Maguire,Imelda 92005)Yoga for a healthy body, London: Greenwich editions.
6. Nagendra H.R. and Nagaratna.R 92004)Yoga prespective in stress management, Bangalore: Swami Vivekananda Yoga prakashan.
7. Nagendra H.R. and Nagaratna.R 92004)Yoga practices for Anxiety and Depression, Bangalore: Swami Sukhabhogananda Yoga prakashan.
8. Sukhabhogananda, Swami (2002) Stress management, Bangalore: Prakashan trust.
9. Udupa (1998)Stress management by Yoga , New Delhi: MotilalBandaridas Publishers pvt. Ltd.
    a. Ravi Shankar N.S. (2001) Yoga for Health, New Delhi: Pustak Mahal.


**Course Outcome:** At the end of this course students will be able to

1. Enhancement of Physical strength and flexibility.
2. Learn to relax and focus.
3. Relieves physical and mental tension
4. Improved work performance/ efficiency.