ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

DEPARTMENT OF ELECTRONICS AND TELEMATICS ENGINEERING
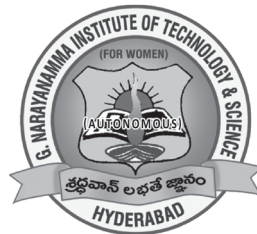
With Specialization in

WIRELESS AND MOBILE COMMUNICATIONS (WMC)

FOR
M.TECH TWO YEAR DEGREE COURSE
(Applicable for the batches admitted from 2022-2023)

G. Narayanamma Institute of Technology and Science
(for women)
(AUTONOMOUS)
Shaikpet, Hyderabad –500104. T.S.

DEPARTMENT OF ELECTRONICS AND TELEMATICS ENGINEERING

DEPARTMENT VISION

Imparting quality technical education in the field of Electronics and Telematics Engineering for women empowerment

DEPARTMENT MISSION

- To emerge as a Centre of Academic Excellence in Electronics and Telematics Engineering to face the challenges in the field of information and communication technologies.

- To create the Educational Environment which enables the students for life long learning.

- Imparting value based education for women empowerment.

G.NARAYANAMMA INSTITUTE OF TECHNOLOGY & SCIENCE (for WOMEN)
(Autonomous)
Shaikpet, Hyderabad – 500 104

ACADEMIC REGULATIONS (R22)
for CBCS Based M.Tech. Degree Programme (Regular/Full Time PG Course) in

WIRELESS AND MOBILE COMMUNICATIONS
(ELECTRONICS AND TELEMATICS ENGINEERING DEPARTMENT)
(Effective for the students admitted into I year from the
Academic Year 2022-23and onwards)

1.0 **Post-Graduate Degree Programme (PGDP) 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 Programmes under Choice Based Credit System (CBCS), with effect from the Academic Year 2022 - 23 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 **PGDP** 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 Programme 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 PGDP - Academic Regulations/Norms.

3.2.1 Semester Scheme:

Each M.Tech. Degree Programme 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 'Elective (Program Specific Elective/ Open Elective)', or 'Mini-Project', or '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**racticalsPeriods:**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.
- Audit Courses shall not carry any Credits.

3.2.3 Subject/ Course Classification:

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

(a) Core Courses (CoC), and

(b) Elective Courses (E*l*C)

Core Courses (CoC) and Elective Courses (E*l*C) are categorized as PS (Professional Subjects), which are further subdivided as –

(i) PC (Professional/ Departmental Core) Courses

(ii) PSE (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 (AC - 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.	**18**
2)	**Elective Courses (E*l*C)**	**PSE – Program Specific Elective**	Includes Elective subjects related to the Parent Department/ Branch of Engg.	**15**
		OE - Open Elective	Elective Courses which include subjects from other technical and/or Emerging Areas	**3**
3)	**Project Related Courses**	**PW - Project Work**	M.Tech. Project or PG Project or PG Major Project (Phase-I and Phase-II)	**26**
		Mini-Project (MP)	Mini-Project over 1 semester duration	**2**
		Seminar	Seminar based on core contents related to the Parent Department/ Branch of Engg. in identified specialization	**2**
4)	Prescribed Course	**AICTE Model Curriculum 2018**	Research Methodology & IPR	**2**
5)	Audit Courses	**AC – as per AICTE Model Curriculum 2018**	Inclusive of AICTE Suggested List	**No Credits**
Total Credits for PGDP (For the Specializations Listed)				**68**

4.0   Course Work

4.1   A student, after securing admission, shall pursue and complete the M.Tech. Degree Programme 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 Programme 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 Programme 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 Programme 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   Thechoice 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 PGDP 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 12 (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 studentshall 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, 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 (24 out of 60 marks)in the Semester End Examination (SEE),
- 40% marks in the Internal Examinations (16 out of 40 marks allotted foe CIE) 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/ Seminars, 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 submit the report) as specified by the Supervisor, or (ii) does not present the Seminars as required, or (ii)

secures less than 50% of Marks (< 50 marks) in evaluations. She may reappear once for each of the 'Mini-Project/ Seminars' evaluations, as and when they are scheduled again; 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 they are scheduled.

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 ≥5.0 (in each semester) and final CGPA (i.e., CGPA at the end of PGDP is to be ≥5.0), to successfully complete the PGDP. **THERE IS NO EXEMPTION OF CREDITS IN ANY CASE**

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 some 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 The students who fail 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 their I Year, shall forfeit their seats in M.Tech. Programme, and their admissions 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 End Semester Examination (ESE) 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 will 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, or Seminar 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 40% CIE and 60% 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: 40 marks for CIE (Continuous Internal Evaluation), and 60 marks for the SEE (Semester End Examination).

9.3   **a)**   In CIE, for theory subjects, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of 2 hours as follows:

1.   Mid-Term Examination for 30 marks:

   a.   Part - A: Objective/quiz paper for 10 marks.

   b.   Part – B: Descriptive paper for 20 marks.

   The objective/quiz paper is set with 10 questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks. The average of the two Mid Term Examinations shall be taken as the final marks for Mid Term Examination (for 30 marks). The remaining 10 marks of Continuous Internal Assessment (out of 40) are distributed as:

2.   Assignment for 5 marks. (Average of 2 Assignments each for 5 marks)

3.   Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned subject for 5 marks.

   While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

   Five (5) marks are allocated for assignments (as specified by the subject teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment (for 5 marks).

   Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned subject for 5 marks before II Mid-Term Examination.

   •   The Student, in each subject, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

   •   *The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.*

   •   *In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE.*

b)   60 marks are allocated for Semester End Examination (SEE), which is of 3 hours duration. The SEE Question Paper will have two parts: Part-A is for 10 marks and is compulsory - it consists of 10 questions of 1 mark each (2 questions from each unit) and Part-B is for 50 marks – it consists of 5 questions of 10 marks each, for each question there will be 'either/ or' choice, which means that there will be two questions from each unit and the student should answer one of these two.

9.4   For the Lab./Practical Subjects, there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks, and Semester End Examination (SEE) at the end of the semester for 60

marks. Out of the 40 marks for Internals, day-to-day work assessment in the laboratory shall be evaluated for 20 marks; the performance in an Internal Lab./Practical Test (10 marks) and viva-voce (10 marks) shall be evaluated for a total of 20 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.

The Student, in each subject, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE

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 40 marks, and SEE shall be for 60 marks. Marks earned under CIE for the 'Mini-Project' 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, and the 'Mini-Project' shall be evaluated by the Committee for 60 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' shall be included in the I Year II Semester Grade Card.

9.6 Electives: 5 Program Specific Elective (PSE) Courses and 1 Open Elective (OE) Course are offered in the 4 Semester PG Degree Programme 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 There shall be Seminar Presentations in the I Year, I and II Semesters. For the Seminar, the student shall collect the information on a technical topic, prepare a Technical Report and submit the Technical Report to the Department at the time of Seminar Presentation. Each Seminar Presentation (along with the Technical Report submitted) shall be evaluated for 100 marks by Two Faculty Members assigned by the Head of the Department. There shall be no SEE or external examination for the Seminar.

9.8 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 considerations and evaluations.

d) 100 marks are allocated for each Phase (Phase-I and Phase-II) of the Project Work, out of which 40 marks shall be for CIE (Continuous Internal Evaluation/CIE), and 60 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 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 plagiarism content to be below the specified level of 30%, 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, Seminars 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 60 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 (with in 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, or 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 ($\geq 90\%$, $\leq 100\%$)	O (Outstanding)	10
Below 90% but not less than 80% ($\geq 80\%$, $< 90\%$)	A^+(Excellent)	9
Below 80% but not less than 70% ($\geq 70\%$, $< 80\%$)	A(Very Good)	8
Below 70% but not less than 60% ($\geq 60\%$, $<70\%$)	B^+(Good)	7
Below 60% but not less than 55% ($\geq 55\%$, $< 60\%$)	B(above Average)	6
Below 55% but not less than 50% ($\geq 50\%$, $< 55\%$)	C(Average)	5
Below 50% ($< 50\%$)	F(FAIL)	0

11.4 A student obtaining F Grade in any Subject shall be considered 'failed'. If a student fails to appear for SEE of any Subject (s) for any reason whatsoever, she is deemed to have 'failed', and she will get F Grade in all such failed Subject (s). She 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 got '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 theGrade Points with Credits for that particular Subject/Seminar/Comprehensive Viva-voce/Project.

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

11.7 The student passes the Subject/ Seminar/ Comprehensive Viva-voce/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 (SCP) 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

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

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_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that i^{th} 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

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

$$\textbf{(ie., upto and inclusive of S semesters, S} \geq \textbf{2)},$$

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_i 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 j^{th} 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 $\geq$ 5.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire PGDP, only when she gets a CGPA $\geq$ 5.00; subject to the condition that she secures a GP $\geq$ 5 (C Grade or above) in every registered Subject/ Course in each semester (during the entire PGDP), 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

$$\textbf{\% of Marks = (final CGPA - 0.5) x 10}$$

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 (PGDP), and secures the required number of 68 Credits (with CGPA $\geq$ 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:

AWARD OF CLASS BASED ON FINAL CGPA (at the end of the PG Programme)

First Class with Distinction	Final CGPA 8.00 or more*
First Class	Final CGPA below 8.00 but not less than 7.00
Second Class	Final CGPA below 7.00 but not less than 6.00
Pass Class	Final CGPA below 6.00 but not less than 5.00

* Note :

a) A student with Final CGPA (at the end of the PG Degree Programme) ≥ 8.00, and fulfilling the following conditions -
(i) should have passed all the Subjects/ Courses within the first 2 Academic Years (or 4 Sequential Semesters) from the Date of Commencement of her First Academic Year,
(ii) should not have been detained or prevented from writing the End Semester Examinations in any semester due to shortage of attendance or any other reason, shall be placed in 'FIRST CLASS with DISTINCTION'.
A student fulfilling the conditions listed under (a) above, alone will be the eligible candidate for the 'University/College Rank' and/or 'Gold Medal' considerations.

b) A student with Final CGPA (at the end of PG Degree Programme) ≥ 8.00, but not fulfilling the above conditions, shall be placed in 'FIRST CLASS'.

13.3 A student with Final CGPA (at the end of the PG Degree Programme) < 5.00 will not be eligible for the Award of the Degree.

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 Programme after the PGDP period of 2 years, may be considered eligible for readmission - to the same PGDP 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.

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.
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 , 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 chiefsuperintendent/assistant –superintendent / any officer on duty or misbehaves or creates disturbance of anykind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, eitherspoken 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 tendencyto 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 alreadyappeared 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. 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 andcancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations andproject 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 university for further action to award suitable punishment.	

M. Tech. 2 Year (4 Semesters) Regular Programme in
WIRELESS AND MOBILE COMMUNICATIONS (WMC)
Department of Electronics & Telematics Engineering
COURSE STRUCTURE
(Applicable for the Batches admitted from the Academic Year 2022-23)

I Year   **I Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PC 1	521EA	Adhoc Wireless Networks	3	0	0	3
2)	PC 2	521EB	Wireless and Mobile Communications	3	0	0	3
3)	PSE 1	**Program Specific Elective - 1**		3	0	0	3
		521EC	Internetworking				
		521ED	Microcontroller and Embedded System Design				
		521EE	Coding Theory and Techniques				
4)	PSE 2	**Program Specific Elective - 2**		3	0	0	3
		521EF	Advanced Digital Signal Processing				
		521EG	Mobile Computing				
		521EH	Detection and Estimation Theory				
5)	PCL 1	52171	Adhoc Wireless Networks Lab	0	0	3	1.5
6)	PCL 2	52172	Wireless and Mobile Communications Lab	0	0	3	1.5
7)	PW	521EJ	Research Methodology and IPR	2	0	0	2
8)	PW	52173	Seminar - 1	0	0	2	1
9)	AC 1	Audit Course - 1		2	0	0	-
		TOTAL		16	0	8	18

I Year   **II Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PC 3	522EK	Advanced Communication Systems	3	0	0	3
2)	PC 4	522EL	Wireless Sensor Networks	3	0	0	3
3)	PSE 3	**Program Specific Elective - 3**		3	0	0	3
		522EM	Network Security and Cryptography				
		522EN	Digital Image and Video Processing				
		522EP	5G Technologies				
4)	PSE 4	**Program Specific Elective - 4**		3	0	0	3
		522EQ	Principles of Artificial Intelligence and Machine Learning				
		522ER	Optical Networking				
		522ES	Software Defined and Cognitive Radio				
5)	PCL 3	52275	Advanced Communication Systems Lab	0	0	3	1.5
6)	PCL 4	52276	Wireless Sensor Networks Lab	0	0	3	1.5
7)	PW	52277	Mini Project	0	0	4	2
8)	PW	52278	Seminar - 2	0	0	2	1
9)	AC 2	Audit Course - 2		2	0	0	-
		TOTAL		14	0	12	18

M. Tech. 2 Year (4 Semesters) Regular Programme in
WIRELESS AND MOBILE COMMUNICATIONS (WMC)
Department of Electronics & Telematics Engineering
COURSE STRUCTURE
(Applicable for the Batches admitted from the Academic Year 2022-23)

II Year   **I Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PSE 5		**Program Specific Elective - 5**	3	0	0	3
		523ET	Voice Over Internet Protocol				
		523EU	Industrial IoT				
		523EV	Multimedia Communications				
2)	OE		**Open Elective**	3	0	0	3
3)	PW	52380	Project / Dissertation (Phase – I)	0	0	20	10
			TOTAL	**6**	**0**	**20**	**16**

II Year   **II Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PW	52481	Project / Dissertation (Phase – II)	0	0	32	16
			TOTAL	**0**	**0**	**32**	**16**

AUDIT COURSES 1&2 :
1. English for Research Paper Writing-521HA/522HA
2. Disaster Management-521HB/522HB
3. SANSKRIT for Technical Knowledge-521HC/522HC
4. Value Education-521HD/522HD
5. Constitution of India-521HE/522HE
6. Pedagogy Studies-521HF/522HF
7. Stress Management by YOGA-521HG/522HG
8. Personality Development through Life Enlightenment Skills-521HH/522HH

OPEN ELECTIVES :
1. Business Analytics—523GA
2. Industrial Safety—523GB
3. Operations Research—523GC
4. Cost Management of Engineering Projects—523GD
5. Composite Materials—523GE
6. Energy from Waste—523GF
7. Power from Renewable Energy Sources—523GG

M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code: 521EA   **3 - - 3**

ADHOC WIRELESS NETWORKS (PC 1)

Prerequisites: Computer Networks.

Course Objectives:
1. To give an overview of the designing issues of MAC, Routing and Transport protocols of Adhoc Networks
2. To provide in depth analysis of various MAC, Routing and Transport protocols and their performance evaluation.
3. To inculcate regarding the security issues in Adhoc networks.
4. To enable the students to understand regarding Quality of Service in Adhoc networks.
5. To provide in depth analysis of various MAC, Routing and Transport protocols and their performance evaluation.
6. To provide in depth analysis of various energy management schemes in Adhoc networks.

UNIT 1: (~10 Lecture Hours)
Medium Access Control Protocols: Introduction, Issues in Designing a MAC protocol, Design goals of a MAC protocol, Classification of MAC protocols, Contention-based protocols, Contention-based protocols with reservation mechanisms, Contention-based MAC protocols with scheduling mechanisms, MAC protocols that use directional antennas,Other MAC protocols.

UNIT 2: (~10 Lecture Hours)
Routing Protocols: Introduction, Issues in designing a routing protocol for adhoc wireless networks, Classification of routing protocols, Table-driven protocols, On-demand routing protocols, Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical routing protocols, Power-aware routing protocols.

UNIT 3: (~9 Lecture Hours)
Transport Layer and security protocols: Introduction to transport layer protocols, Issues in designing a transport layer protocol for adhoc wireless networks, Design goals of transport layer protocol for adhoc wireless networks,Classification of transport layer solutions, TCP over adhoc wireless networks, Other transport layer protocols for adhoc wireless networks. Security in adhoc wireless networks, Network security requirements, Issues and challenges in security provisioning, Network security attacks.

UNIT 4: (~9 Lecture Hours)
Qos in Adhoc Wireless networks: Introduction, Realtime traffic support in adhoc wireless networks, Quality of service parameters in adhoc wireless networks, Issues and challenges in providing QoS in adhocwireless networks, Classification of QoS solutions: MAC layer solutions, Network layer solutions,QoS frame works for adhoc wireless networks.

UNIT 5: (~9 Lecture Hours)
Energy Management in Adhoc Wireless Networks: Introduction, Need for energy management in Adhoc Wireless Networks, Classification of Energy Management Schemes, Battery Management Schemes, Transmission Power Management Schemes, System Power Management Schemes.

Text Books:
1. C.Siva Ram Murthy, "AdHoc Wireless Networks", Pearson Education, 2004.
2. P Nicopolitidis and M.S.Obaidat, "Wireless Networks", Wiley India Edition, 2003.

Reference Books:
1. C.K.Toh, "Ad-Hoc MobileWireless Networks: Protocols and Systems", Pearson Education,1ˢᵗ Edn.
2. Carlosde Morais Cordeiro and Dharma Prakash Agrawal, "AdHoc and Sensor Networks", World Scientific, 2011.
3. Kazen Sohra by, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks", Wiley Student Edition, 1991.
4. C.S.Raghavendra, Krishna M.Siva Lingam, "Wireless Sensor Networks", Springer, 2004.
5. Jagannathan Sarangapani,"Wireless Ad-hoc and Sensor Networks: Protocols, Performance and Control",CRC Press.

Online Resources:
1. https://archive.nptel.ac.in/courses/106/105/106105160/
2. http://edusparkz.com/course_details?course_id=11142

Course Outcomes (COs)

After completion of the course students should be able to:
1. Understand the fundamental concepts related to Adhoc wireless Networks.
2. Understand the designing issues of MAC, Routing and Transport protocols of Adhoc wireless Networks.
3. Classify the protocols at MAC layer, Network Layer and Transport layer.
4. Analyze various MAC, Routing and Transport protocols and their performance evaluation.
5. Analyze network level security issues, Qualityof Service solutions and energy management schemes in Adhoc wireless networks.
6. Design energy efficient secured protocols to improve the network performance of Adhoc wireless networks.

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M. Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EB   **3 - - 3**

WIRELESS AND MOBILE COMMUNICATIONS (PC 2)

Prerequisite: 1.Analog and Digital 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 and Capacity in Cellular Systems–cell splitting, sectoring, Comparison of 1G, 2G, 3G and 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, Selection diversity, Feedback diversity, Maximal ratio combining, Equal gain diversity, 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. Upena Dalal, "Wireless Communication", Oxford University Press, 8th Impression, 2015.

Reference Books:

1. Kaveh Pahlaven 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 Resorces:

1. http://nptel.ac.in/courses/117104099/
2. http://nptel.ac.in/courses/117102062/

Course Outcomes (COs)

After completion of the course students should 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 equalization.

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M.Tech. WMC I Year, I Sem   **L T P C**
Course Code:521EC   **3 - - 3**

INTERNETWORKING (PSE 1)

Prerequisites: Computer Networks.

Course Objectives:
1. To define the basic taxonomy and terminology of the computer networking area of the fundamental concepts of computer networking.
2. To illustrate the functionality of Various layers of Reference model.
3. To compare and contrast various protocols at different layers.
4. To find the set of protocols suitable for the given application.
5. To evaluate the architecture of various application-level protocols.
6. To understand the messages getting exchanged at several layers of the network.

UNIT 1: (~8 Lecture Hours)
Overview of the Internet: Introduction, The OSI model and TCP/IP Protocol suite.
Physical Layer: Guided transmission media, Wireless transmission media
Underlying Technologies: Wired LANS, Wireless LANs
Multiple access protocols: ALOHA, CSMA
Data Link layer Switching: Use of bridges, learning bridges, spanning tree bridges, repeaters, hubs, bridges, switches, routers and gateways.

UNIT 2: (~12 Lecture Hours)
Internetworking: How networks differ, How networks can be connected, Tunneling, internetwork routing, packet fragmentation.
Network Layer: Classful addressing: Introduction, Classful Addressing, Other Issues, Subnetting and Supernetting, Classless Addressing: - Variable length Blocks, Subnetting, Address Allocation.
Delivery, Forwarding, and Routing of IP Packets: Delivery, Forwarding, Routing, Structure of Router.
Internet Protocol (IP): Datagram, Fragmentation, Options, Checksum
ARP and RARP: ARP, ARP Package, RARP.
IPv6: Introduction, Address space allocation, Packet format, transmission from IPv4 to IPv6.

UNIT 3: (~10 Lecture Hours)
Transmission Control Protocol (TCP):
TCP Services, TCP Features, Segment, A TCP Connection, State Transition Diagram, Flow Control, Error Control, Congestion Control, TCP Timer.
Stream Control Transmission Protocol (SCTP): SCTP Services, SCTP Features, Packet Format, Flow Control, Error Control, Congestion Control.

UNIT 4: (~8 Lecture Hours)

Unicast Routing Protocols (RIP, OSPF, and BGP): Intra and Inter-domain Routing, Distance Vector Routing, RIP, Link State Routing, OSPF, Path Vector Routing, BGP.

Multicasting and Multicast Routing Protocols: Unicast - Multicast- Broadcast, Multicast Applications, Multicast Routing, Multicast Link State Routing, MOSPF, Multicast Distance Vector, DVMRP.

UNIT 5: (~10 Lecture Hours)

Application Layer:

Domain Name System (DNS): Name Space, Domain Name Space, Distribution of Name Space, and DNS in the internet.

Remote Login Telnet:- Concept, Network Virtual Terminal (NVT).

File Transfer FTP and TFTP: File Transfer Protocol (FTP).

Electronic Mail: SMTP and POP.

Network Management-SNMP: Concept, Management Components.

World Wide Web- HTTP Architecture.

Text Books:
1. TCP/IP Protocol Suite- Behrouz A. Forouzan, Fourth Edition, TMH
2. Computer Networks- Andrew S Tanenbaum, 4th Edition, Pearson Education.

Reference Books:
1. Internetworking with TCP/IP Comer 3rd edition PHI
2. High performance TCP/IP Networking- Mahbub Hassan, Raj Jain, PHI, 2005
3. Data Communications & Networking – B.A. Forouzan – 2nd Edition – TMH
4. High Speed Networks and Internets- William Stallings, Pearson Education, 2002.
5. Data and Computer Communications, William Stallings, 7th Edition., PEI.

Online Resources:
1. http://nptel.ac.in/syllabus/106105081/
2. https://in.udacity.com/course/computer-networking—ud436
3. http://nptel.ac.in/syllabus/106105082/
4. http://www.cse.wustl.edu/~jain/

Course Outcomes (COs)

After completion of the course students should be able to:
1. Understand the basic taxonomy and terminology of the computer networking.
2. Enumerate functionality of Various layers of Reference model.
3. Differentiate various protocols at different layers.
4. Apply the appropriate protocol for required application.
5. Acquaint with the knowledge of the architecture of various application level protocols.
6. Understanding various types of messages being exchanged at different layers of an Internet.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521ED   **3 - - 3**

MICROCONTROLLER AND EMBEDDED SYSTEM DESIGN (PSE 1)

Prerequisite: -

Course Objectives:
1. To study the basics of Embedded Systems.
2. To understand the basics of organizational and architectural issues of a Microcontroller.
3. To realize the interfacing of peripherals with 8051.
4. To learn about design approaches and programming techniques used in Embedded System Design.
5. To apply the fundamentals of Real-time operating systems (RTOS) to design an Embedded System.

UNIT 1: (~12 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.
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: On-board and External Communication Interfaces.

UNIT 2: (~10 Lecture Hours)
Designing Embedded Systems with Microcontroller: Factors to be considered in selecting a microcontroller, why 8051 microcontroller, designing with 8051, memory organization, registers, oscillator unit, ports, interrupts, 8051 interrupts systems, timer units, serial port, reset circuitry, power saving modes.
Programming the 8051 Microcontroller: Addressing supported by 8051 with examples, instruction sets - data transfer, arithmetic, logical, Boolean, control transfer with programs.

UNIT 3: (~8 Lecture Hours)
Real World Interfacing: Interfacing an LCD to 8051, Interfacing ADC to 8051, Interfacing sensor to 8051, Interfacing a Stepper motor, 8051 interfacing to Keyboard, Interfacing DAC, Interfacing external memory to 8051, Interfacing 8051 with 8255.

UNIT 4: (~8 Lecture Hours)
Embedded Firmware Design Approaches: Super loop-based Approach, Embedded OS-based Approach.
Embedded Firmware Development Languages: Assembly Language, High Level, Language, Mixing of Assembly Language with High-Level Language.

UNIT 5: (~10 Lecture Hours)
RTOS-based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication - Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization - Task Communication/ Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

Text Books:

1. Introduction to Embedded Systems by Shibu K. V., McGraw Hill Education, 2nd Edition, 2009.
2. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice Gillispie Mazidi, Pearson Education, 2003.

Reference Books:

1. Embedded / Real – Time Systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech Press, 2011.
2. Embedded System Design by Frank Vahid & Tony Givargis, Wiley India Edition, 2002.

Online Resources:

1. https://nptel.ac.in/courses/108102169 (Course Title: Introduction to Embedded System Design, Prof. Dhananjay V. Gadre, Prof. BadriSubudhi , Netaji Subhas University of Technology, IIT Jammu).
2. https://www.coursera.org/learn/introduction-embedded-systems (Course Title: Introduction to Embedded Systems Software and Development Environments, Alex Fosdick, Electrical, Computing, and Energy Engineering Program, University of Colorado Boulder).

Course Outcomes (COs)

After completion of the course students should be able to:

1. Understand basic architecture and concepts of Embedded Systems.
2. Apply the knowledge of microcontrollers in Embedded System Design.
3. Understand the interfacing of microcontrollers with peripherals.
4. Analyze the design approaches and development languages required to design an Embedded System.
5. Design and implement an Embedded System using RTOS.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EE   **3 - - 3**

CODING THEORY AND TECHNIQUES (PSE 1)
(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 the 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.

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, Majority logic decoding for cyclic codes. Introduction to BCH codes.

UNIT 3: (~8 Lecture Hours)
Convolutional Codes: Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, 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 & LDPC Codes:
Turbo Codes: Concatenated convolutional codes- Parallel concatenation, the UMTS Turbo code, Serial concatenation, Partial concatenation, Turbo decoding.
LDPC Codes: Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Belief propagation, Product codes, Iterative decoding of product codes.

UNIT 5: (~8 Lecture Hours)

Space-Time Codes: Introduction, Digital modulation schemes, Diversity, Orthogonal space- Time Block codes: Alamouti's schemes, Extension to more than Two Transmit Antennas, Simulation Results, Spatial Multiplexing: General Concept, Iterative APP Preprocessing, and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition, and Interface Cancellation, Performance of Multi-Layer Detection Schemes, Unified Description by Linear Dispersion Codes.

Text Books:

1. Shu Lin, Daniel J.Costello, Jr, "Error Control Coding- Fundamentals and Applications", 2nd Editions, Prentice Hall, 2017.
2. Andre Neubauer, Jurgen Freadenberger, Volker Kuhn, "Coding Theory- Algorithms, Architectures and Applications", 1st Edition, John Wiley & Sons Ltd, 2007.

Reference Books:

1. Bernard Sklar, "Digital Communications-Fundamentals and Applications", 2nd Edition, PEA, 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 Title: Coding Theory, Dr. Andrew Thangaraj, IIT Madras)

2. https://nptel.ac.in/courses/117108044

(Course Title: Error Correcting Codes, Prof. P. Vijay Kumar, IISc Bangalore)

Course Outcomes (COs)

After completion of the course students should be able to:

1. Narrate the need and basics for error detecting and correcting codes in data communications and storage systems.
2. Explain the operating principle of block codes, cyclic codes, convolution codes, turbo codes, LDPC codes and space-time codes.
3. Apply mathematical tools like finite fields for designing multiple error correcting codes.
4. Analyze the error detection and correction capabilities of various codes.
5. Compare the performances of error correcting codes in terms of channel parameters and probability of error.
6. Choose the appropriate error correcting scheme according to the BER and signal-to-noise ratio and specify the requirement.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EF   **3 - - 3**

ADVANCED DIGITAL SIGNAL PROCESSING (PSE 2)
(Common to DECE, WMC)

Prerequisite: Digital Signal Processing.

Course Objectives:
1. To understand the importance of multirate digital signal processing and applications.
2. To have in-depth knowledge of linear prediction and power spectral estimation methods
3. To develop an understanding of subspace methods of power spectral estimation.
4. To compare the performance methods of parametric, non-parametric and subspace methods of power spectral estimation techniques.

UNIT 1: (~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 2: (~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 3: (~9 Lecture Hours)
Non-Parametric Methods of Power Spectral Estimation: Estimation of Spectra from Finite Duration Observation of Signals, Non-Parametric Methods: Bartlett, Welch and Blackman-Tukey Methods, Performance Characteristics of Non-Parametric Power Spectrum Estimators. Computational Requirements of Non-Parametric Power Spectrum Estimates.

UNIT 4: (~8 Lecture Hours)
Parametric Methods of Power Spectrum Estimation: Relation between Auto Correlation and Model Parameters, AR Models - Yule-Walker and Burg Methods, MA Model for Power Spectrum Estimation, ARMA Model for Power Spectrum Estimation.

UNIT 5: (~10 Lecture Hours)

Minimum Variance and Eigen Analysis based Spectral Estimation: Minimum Variance Spectrum Estimation, Eigen Analysis Algorithm for Spectral Estimation-Pisarenko Harmonic Decomposition Method, Eigen Decomposition of Autocorrelation Matrix for Sinusoids in White Noise, MUSIC Algorithm, ESPRIT Algorithm, Order Selection Criteria, Comparison of Experimental Results for Spectral 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 and Ronald W. Schaffer, "Discrete Time Signal Processing", 2nd Ed, PHI, 2007.

Reference Books :
1. Emmanuel C. Ifeachor and Barrie W. Jervis. Addison "Digital Signal Processing: A Practical Approach", 2nd Edition, Pearson, 2002.
2. S. M .Kay, "Modern spectral Estimation techniques", 1st Edition, PHI, 1997.
3. P.P. Vaidyanathan "Multi Rate Systems and Filter Banks", Pearson Education, 1993.

Online Resources:
1. https://nptel.ac.in/courses/117108040
   (Course Title: Digital System Design with PLDs and FPGAs, Prof. Kuruvilla Varghese IISc Bangalore)
2. https://onlinecourses.nptel.ac.in/noc22_ee110/preview
   (Course Title: Digital Circuits, Prof. Santanu Chattopadhyay IIT Kharagpur)

Course Outcomes (COs)

After completion of the course students should be able to:
1. Define the basic features of multirate digital signal Processing, Spectral estimation techniques and describe the sampling rate conversion principles.
2. Describe the relationship between the filter parameters and autocorrelation sequences for linear prediction and optimum filtering.
3. Identify the non-parametric methods of power spectral estimation, their computational requirements and calculate the performance characteristics.
4. Analyze the parametric methods of power spectral estimation using AR, MA,ARMA Models.
5. Assess and compare the power spectral estimates using minimum variance and eigen analysis based methods.
6. Discuss and compare the subspace methods of spectral estimation employing MUSIC and ESPRIT algorithms.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EG   **3 - - 3**

MOBILE COMPUTING (PSE 2)
(Common to DECE, WMC)

Prerequisite: Computer Networks, Computer Organization and architecture.

Course Objectives:
1. To learn the fundamental technologies that help in the networking of wireless devices.
2. To study the cellular architectures of GSM, GPRS, SMS.
3. To have an exposure about emerging technologies like Blue tooth, WiMAX etc.
4. To know the Network, Transport functionalities of Mobile Communication.
5. To impart knowledge about Mobile Application Development using Palm OS, Symbian OS, J2ME etc.

UNIT 1: (~9 Lecture Hours)
Introduction to Mobile Computing Architecture: Mobile Computing, dialog control, networks, middleware and gateways, application and services, developing mobile computing applications, security in mobile computing, architecture for mobile computing, three tier architecture, design considerations for mobile computing, mobile computing through internet, making existing applications mobile-enabled.

UNIT 2: (~9 Lecture Hours)
Cellular Technologies – GSM, GPRS, CDMA AND 3G : Wireless Broadband, mobile IP, Internet protocol version 6 (IPv6), Java card, PLNM interfaces, GSM addresses and identifiers, network aspects in GSM, Mobile computing over SMS, Short Message Services (SMS), GPRS network architecture, GPRS network operations, data services in GPRS, applications for GPRS, limitations of GPRS, CDMA versus GSM, third generation networks, applications on 3G, Introduction to 4G & 5G Communications.

UNIT 3: (~8 Lecture Hours)
Wireless Application Protocol (WAP) and Wireless LAN: WAP, MMS, wireless LAN advantages, IEEE 802.11 standards, wireless LAN architecture, mobility in wireless LAN.
Intelligent and Internetworking: Introduction, fundamentals of call processing, intelligence in the networks, SS7 signaling, IN Conceptual Model (INCM), Softswitch, programmable networks, technologies and interfaces for IN.

UNIT 4: (~10 Lecture Hours)
Client Programming, PALM OS, SYMBIAN OS, WIN CE Architecture: Introduction, moving beyond the desktop, a peek under the hood: hardware overview, mobile phones, PDA, design constraints in applications for handheld devices, palm OS architecture, application development, Symbian OS architecture, Applications for Symbian, different flavors of windows CE, windows CE architecture.
J2ME: Java in the handset, the three prong approach to JAVA everywhere, JAVA 2 micro edition (J2ME) technology, programming for CLDC, MIDLet, Optional packages.

UNIT 5: (~9 Lecture Hours)

Voice Over Internet Protocol and Convergence:

Voice over IP, H.323 Framework for voice over IP, Session Initiation Protocol, Comparison between H.323 and SIP, Real Time protocols, Convergence Technologies, Call Routing, IP multimedia subsystem (IMS), Mobile VoIP.

Security Issues in Mobile Computing: Introduction, information security, security techniques and algorithms, security protocols, trust, security models, security frameworks for mobile environment.

Text Books:

1. Mobile Computing – Technology, Applications and Service Creation, Asoke K. Talukder, Roopa R Yavagal, 2nd edition, Tata McGraw Hill, New Delhi, 2009.
2. Mobile Communications, Jochen Schiller, 2nd Edition, Pearson Education, New Delhi, 2008.

Reference Books:

1. The cdma 2000 system for Mobile Communications, Vieri Vanghi, Aleksander Damnjanovic, Pearson Education, New Delhi, 2007.
2. Fundamentals of Mobile and Pervasive Computing, Frank Adelstein, McGraw Hill, New Delhi, 2008.

Online Resources:

1. https://www.tutorialspoint.com/mobile_computing/mobile_computing_overview.htm
2. http://uberthings.com/mobile/#intro
3. http://www.ittoday.info/Articles/Introduction_to_Mobile.htm

Course Outcomes (COs)

After completion of the course students should be able to:

1. Articulate the basics of Mobile Computing and Communication standards.
2. Describe Mobile Communication and Computing Architectures.
3. Demonstrate the knowledge of various platforms like Palm OS, Symbian OS and Windows CE used for mobile devices.
4. Develop mobile applications using JAVA 2 micro edition (J2ME) technology.
5. Differentiate H.323, SIP and other protocols, frameworks for VoIP.
6. Analyze various security protocols and able to deal with security attacks in mobile environment.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EH   **3 - - 3**

DETECTION AND ESTIMATION THEORY (PSE 2)

Prerequisite: Basic Mathematics.

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.

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 PearsonTheorem, 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 (OnlyBinaryCase), 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, VolumeII: 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, Babak Hassibi, 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. https://www.youtube.com/playlist?list=PL48UwQJyfW3SmrjLgl5LrVciqfWz9XazY
2. https://www.youtube.com/watch?v=09eXRHf6glA

Course Outcomes (COs)

After completion of the course students should 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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M.Tech. WMC I Year, I Sem.   **L T   P   C**
Course Code:52171   **-   - 3 1.5**

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ADHOC WIRELESS NETWORKS LAB (PCL 1)

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Prerequisite: Computer Networks, Adhoc Wireless Networks.

Course Objectives:
1.   To simulate various LAN topologies, IEEE 802.11 and IEEE 802.15.4
2.   To simulate various queue management schemes and scheduling mechanisms in wireless scenarios.
3.   To simulate different transport and routing protocols in MANETs.
4.   To analyze various Internet packets and protocols.
5.   To analyze OFDM spectrum and CDMA 2000 system.

Experiments:
Note :
A. All the experiments may be conducted using Network Simulation Software like NS-2/NSG-2.1, Wireshark, SDR, Matlab.
B. Experiments 1 to 7 may be evaluated through simulation by using the parameters Throughput, Packet Delivery Ratio, Endto end Delay.
1.   Evaluate the performance of various wired LAN Topologies.
2.   Evaluate the performance of Drop Tail and RED queue management schemes in wired networks.
3.   Evaluate the performance of CBQ and FQ Scheduling Mechanisms in wired networks.
4.   Evaluate the performance of TCP and UDP Protocols in wireless networks.
5.   Evaluate the performance of TCP, New Reno and Vegas in wireless networks.
6.   Evaluate the performance of AODV, DSR and DSDV routing protocols in wireless networks.
7.   Evaluate the performance of IEEE 802.11 and IEEE 802.15.4 in wireless networks.
8.   Capturing and Analysis of TCP and IP Packets.
9.   Capturing and Analysis of ICMP and IGMP Packets.
10. Analyze the Protocols SCTP, ARP, Net BIOS, IPX VINES.
11. Analysis of HTTP, DNS and DHCP Protocols.
12. Design OFDM System using SDR and observe its spectrum.
13. Performance evaluation of CDMA system in multi user environment.

OnlineResources:
1.   https://archive.nptel.ac.in/courses/106/105/106105160/
2.   http://edusparkz.com/course_details?course_id=11142

Course Outcomes (COs)
After completion of the course students should be able to:
1.   Compare the performance of LAN topologies, IEEE 802.11 and IEEE 802.15.4.
2.   Analyze various queue management schemes and scheduling mechanisms in wireless environment..
3.   Evaluate the performance of various transport and routing protocols in MANETs
4.   Analyze various Internet packets and protocols using Wireshark.
5.   Develop OFDM and CDMA system.

M.Tech. WMC I Year, I Sem.   **L T   P   C**
Course Code:52172   **-   -   3 1.5**

WIRELESS AND MOBILE COMMUNICATIONS LABORATORY (PCL 2)

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 MAT LAB 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 MAT LAB 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.

Course Outcomes (COs)
After completion of the course students should 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.

M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code:521EJ   **2 - - 2**

RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (PW)

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 versus Methodology, Research and Scientific Methods, Importance 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: (~5 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: (~5 Lecture Hours)
Nature of Intellectual Property: Patents, Designs, Trademarks and Copyrights. Process of Patenting and Development: technological research, innovation.

UNIT 5: (~8 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
2. https://onlinecourses.nptel.ac.in/noc20_hs55
3. https://onlinecourses.nptel.ac.in/noc20_hs54

Course Outcomes:

After completion of the course the student should be able to:

1. Describe research problem formulation and outline the Research Design process.
2. Identify the various methods of Data Collection.
3. Demonstrate the ability to draft Research Report, Synopsis and Dissertation with appropriate Bibliography/ Webliography while conforming to research ethics.
4. Categorize various forms of Intellectual Property and list out the steps involved in Patenting.
5. Justify the need for Patenting and Transfer of Technology in the socio-economic growth of the society.
6. Develop a Research Proposal and Research Grant Proposal.

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M.Tech. WMC I Year, ISem.   **L T P C**
Course Code: 521HA/522HA   **2 - - -**

ENGLISH FOR RESEARCH PAPER WRITING
(Audit Course-1)

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 writing a Research Paper.
4. To enable the students to evolve original research papers without subjected to plagiarism.

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.

Reference Books:
1. MLA Hand book for writers of Research Papers, East West Press Pvt.
2. C. R Kothari, Gaurav, Garg, Research Methodology Methods and Techniques, New Age International Publishers. 4th Edition.
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

Online Resources:
1. NPTEL: https://onlinecourses.nptel.ac.in/noc18_mg13/preview

Course Outcomes:
After completion of the course, students will be able to
1. Understand the nuances of research writing.
2. Write a research paper with required writing skills and be confident to share their writing with others.
3. Publish a paper using the requisite standard in a journal.
4. Review the research papers and articles in a scientific manner.
5. Work on citations and ably place them in her research paper.
6. Avoid plagiarism with an ability to develop her own writing skills in presenting the research work.

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M.Tech. WMC I Year, I Sem.   **L   T   P   C**
Course Code: 521HB/522HB   **2   -   -   -**

DISASTER MANAGEMENT
(Audit Course-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. Disaster Management Cycle.

UNIT 4: (~5 Lecture Hours)
Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, People's Participation Risk Assessment, Strategies for Survival, Case Studies of Global, National and Local disasters, Techniques of Risk reduction for different disasters.

UNIT 5: (~5 Lecture Hours)
Disaster Risk Reduction &Mitigation: Meaning, Environment Security, Climate Change & Security risks,

Climate Security Mechanism, Environmental Cooperation and Peace Building, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation - Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India. Role of NDMA in Disaster Mitigation in India.

Text Books:

1. R. Nishith, Singh A.K,. "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.
6. UNEP.org- ECO - DRR

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
7. https://www.unep.org/explore-topics/disasters-conflicts/what-we do/disaster-risk-reduction/ecosystem-based-disaster-risk

Course Outcomes:

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

1. Acquire the knowledge of different disasters and measures to reduce the risk due to these disasters.
2. Plan institutional framework for disaster management at national as well as global levels.
3. Analyze, evaluate and manage the different public health aspects of disaster events at local and global levels, even when limited information is available.
4. Develop capacity to describe, the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.
5. Acquire the knowledge on 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.

M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code: 521HF/522HF   **2 - - -**

PEDAGOGY STUDIES
(Audit Course-1)

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: (~ 8 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: (~ 6 Lecture Hours)
Thematic overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT 3: (~ 6 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: (~ 6 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: (~ 6 Lecture Hours)
Research gaps and future directions - Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Reference Books:

1. Ackers J and 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. Akyeampong K, (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 and 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.
7. www.pratham.org/images/resources%20working%20paper%202.pdf.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc17_ge03/preview

Course Outcomes:

After learning the contents of this course, the students will be able to

1. The pedagogical practices followed by teachers in developing countries both informal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Importance of the role of teacher education, school curriculum and guidance materials for effective pedagogy.
5. Identify the critical evidence gaps in teaching – learning and to develop strategic plan to fill the gaps.
6. Develop appropriate resources in alignment with the curriculum and its objectives.

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M.Tech. WMC I Year, I Sem.   **L T P C**
Course Code: 521HH/522HH   **2 - - -**

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit Course-1)

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: (~ 6 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: (~ 6 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: (~ 7 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: (~ 7 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: (~6 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.

Reference 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.

Online Courses:
1.   NTPEL: http://nptel.ac.in/downloads/109104115/

Course Outcomes:
After learning the contents of this course, the 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.
4.   Harmonize peace and mental well-being to handle day-to-day works more productively.
5.   Understand oneself for holistic development.
6.   Explore one's own potential to enhance their productive work.

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M.Tech. WMC I Year, II Sem.   **L   T   P   C**
Course Code:522EK   **3   -   -   3**

ADVANCED COMMUNICATION SYSTEMS (PC 3)

Prerequisite: Wireless & Mobile Communications.

Course Objectives:
1. To expose the students to the principles of spread spectrum and their applications to communication systems.
2. To understand basic requirements of MIMO system.
3. To analyse OFDM signal Bandwidth, channel estimation techniques.
4. To familiarize SONET, ATM frame formats.

UNIT 1: (~8 Lecture Hours)
Spread Spectrum Communications: Fundamental Concepts of Spread Spectrum Systems, Properties of Spreading Sequences, Pseudo- noise sequence, Walsh Sequences, Orthogonal Variable Spreading Factor Sequences, Barker Sequence, Complementary Codes. Direct sequence spread spectrum, Frequency Hop spread spectrum ,Hybrid Direct Sequence Frequency Hop spread spectrum, Code Division Multiple Access, Synchronization in CDMA, Power Control, Soft handoff, Multiuser detection – Optimum multiuser detector, Liner multiuser detection.

UNIT 2: (~9 Lecture Hours)
Orthogonal Frequency Division Multiplexing: Basic Principles of Orthogonality, Single vs Multicarrier Systems, OFDM Block Diagram and Its Explanation, OFDM Signal Mathematical Representation, Selection parameter for Modulation, Pulse shaping in OFDM Signal and Spectral Efficiency, Window in OFDM Signal and Spectrum, Synchronization in OFDM, Pilot Insert in OFDM Transmission and Channel Estimation, Amplitude Limitations in OFDM, FFT Point Selection Constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

UNIT 3: (~10 Lecture Hours)
MIMO Systems: Introduction, Space Diversity and System Based on Space Diversity, Smart Antenna system and MIMO, MIMO Based System Architecture, MIMO Exploits Multipath, Space – Time Processing, Antenna Consideration for MIMO, MIMO Channel Modelling, MIMO Channel Measurement, MIMO Channel Capacity, Cyclic Delay Diversity (CDD), Space Time Coding, Advantages and Applications of MIMO in Present Context, MIMO Applications in 3G Wireless System and Beyond, MIMO-OFDM.

UNIT 4: (~8 Lecture Hours)
SONET/SDH: Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks, Virtual Tributaries.
ATM: Overview, Virtual channels, Virtual paths, VP and VC switching, ATM cells, Header format, Generic flow control, Header error control, Transmission of ATM cells, Adaptation layer, AAL services and protocols.

UNIT 5: (~10 Lecture Hours)

ATM Traffic and congestion Control: Requirements for ATM Traffic and Congestion Control, Cell-Delay Variation, ATM Service Categories, Traffic and Congestion Control Framework, Traffic Control, Congestion Control.

Text Books:

1. Gary J. Mullett, "Introduction to Wireless Telecommunications Systems and Networks", CENGAGE.
2. UpenaDalal, "Wireless Communication", Oxford University Press, 2009
3. William Stallings, "ISDN and Broadband ISDN with Frame Relay and ATM" Prentice Hall, 4th edition.
4. Rodger E Ziemer, Roger L. Peterson and David E Borth - "Introduction to Spread Spectrum Communication-Pearson, 1st Edition, 1995.
5. Rainer Handel, Manfred N Huber, Stefan Schroder, "ATM Networks, Concepts, Protocols and Applications", Addison - Wesley, 3rd Edition, 1999.

Reference Books:

1. Ke-Lin Du & M N S Swamy, "Wireless Communication System", Cambridge University Press, 2010.
2. Behrouz A Forouzan, "Data Communications and Networking", 4th Edition, McGraw Hill.
3. Gottapu Sasibhusan Rao, "Mobile Cellular Communication", PEARSON.

Online Resources:

1. nptel.ac.in/courses/117101050/6
2. nptel.ac.in/courses/106105081/24
3. http://nptel.ac.in/courses/117104099

Course Outcomes (COs)

After completion of the course students should be able to:

1. Gain the fundamental concepts of spread spectrum concepts in wireless communication system.
2. Apply space time coding in MIMO system.
3. Develop channel modeling of a MIMO system.
4. Analyze mathematical representation of OFDM system.
5. Estimate channel in OFDM environment.
6. Comprehend ATM traffic and congestion control.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code:522EL   **3 - - 3**

WIRELESS SENSOR NETWORKS (PC 4)

Prerequisite: 1.Computer Networks 2.Adhoc Wireless 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: Motivation for a Network of Wireless Sensor Nodes, Challenges and constraints of wireless sensor networks, Comparison between wireless sensor networks and traditional networks, Applications.
Node Architecture: The Sensing Subsystem, the Processor Subsystem, Communication Interfaces, Prototypes.
Operating Systems: Functional and Non-functional Aspects, Prototypes, Evaluation.

UNIT 2: (~10 Lecture Hours)
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: (~10 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. Waltenegus Dargie, 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. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley, 2010.
2. C.S. Raghavendra, K.M. Sivalingam, TaiebZnati, "Wireless Sensor Networks", Springer, 2010
3.   C. Sivarmmurthy& B.S. Manoj, "Adhoc Wireless Networks",1st Edition, PHI,2004.
4. Fei Hu., Xiaojun Cao, "Wireless Sensor Networks",1st Edition, CRC Press, 2013.
5. Carlos de Morais Cordeiro & Dharmaprakash Agarwal," Adhoc & wireless sensor, 2nd edition, World Scientific & Imperial college press, 2006.
6. Sunil Kumar, S. Manvi, Mahabaleshwar, "wireless and sensor mobile networks concepts and protocols" Wiley, 2010.

Online Resources:

1. http://nptel.ac.in/syllabus/106105160/
2. https://www.hkr.se/en/course/DT573B/course-syllabus

Course Outcomes (COs)

After completion of the course students should be able to:

1. Explore various applications of sensor networks.
2. Understand various challenges in designing sensor networks.
3. Differentiate various sensor platforms and supporting protocols.
4. Analyze various sensor network simulators and sensor network programming tools.
5. Design wireless sensor networks by considering appropriate protocols at various levels
6. Evaluate the security issues of Wireless sensor networks.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code:522EM   **3 - - 3**

NETWORK SECURITY AND CRYPTOGRAPHY (PSE 3)

Prerequisites: Computer Networks.

Course Objectives:
1. To understand the fundamentals of Cryptography.
2. To acquire knowledge on standard security services and mechanisms used to provide confidentiality, integrity and authenticity.
3. To understand the various key distribution and management schemes.
4. To understand how to deploy encryption techniques to secure data in transit across data networks.

UNIT 1: (~8 Lecture Hours)
Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security.
Classical Encryption Techniques: Symmetric cipher model, Substitution Techniques, Transposition techniques, Rotor machines, Steganography.
Modern Techniques: Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis.

UNIT 2: (~8 Lecture Hours)
Advanced Encryption Standard: The origin of AES, AES structure, AES Key expansion.
Block Cipher Operation: Triple DES, Modes of operation: ECM, CBC, CFB, OFM, Counter mode.
Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

UNIT 3: (~10 Lecture Hours)
Number Theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for Primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.
Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.

UNIT 4: (~10 Lecture Hours)
Hash functions: Applications, two simple Hash functions, requirements and security, hash functions based on cipher block chaining, SHA, SHA-3.
Message Authentication and Hash Functions: Authentication requirements and functions, Message Authentication codes, Security of MACs , HMAC.
Digital signatures and Authentication protocols: Digital signatures, Digital signature standards
Key management & Distribution: Symmetric key distribution, Distribution of public keys, X.509 Certificates.

UNIT 5: (~10 Lecture Hours)

User Authentication Applications: Kerberos

Web Security: Web Security requirements, Secure socket layer and Transport layer security.

Electronic Mail Security: Pretty Good Privacy, S/MIME.

IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management.

Text Books:

1. Cryptography and Network Security: Principles and Practice - William Stallings, Pearson Education, 5th Edition.
2. Network Security Essentials (Applications and Standards) - William Stallings Pearson Education.

Reference Books:

1. Fundamentals of Network Security - Eric Maiwald (Dreamtech press)
2. Network Security - Private Communication in a Public World - Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
3. Principles of Information Security - Whitman, Thomson.
4. Network Security: The complete reference - Robert Bragg, Mark Rhodes, TMH
5. Introduction to Cryptography - Buchmann, Springer.

Online References:

1. http://www.cse.wustl.edu/~jain/
2. http://nptel.ac.in/syllabus/106105031/
3. https://onlinecourses.nptel.ac.in/noc18_cs07/preview

Course Outcomes (COs)

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

1. Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
2. Discuss standard security services and mechanisms used to provide confidentiality, integrity and authenticity.
3. Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.
4. Effectively understand and apply various message authentication techniques and Secure Hash algorithms to specific application.
5. Discuss different levels of security.
6. Apply the knowledge and abide by the legal framework that governs computer and information systems.

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M.Tech. I Year, II Sem.   **L T P C**
Course Code:522EN   **3 0 0 3**

DIGITAL IMAGE & VIDEO PROCESSING (PSE 3)

Prerequisite: Digital Signal Processing.

Course Objectives:
1. To provide fundamentals of Digital Image Processing.
2. To give the students a taste of applications of the theories taught in the subject.
3. To introduce few advanced topics in Image and Video Processing.
4. To 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, Pseudocolor 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, Joem Ostermann 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. http://nptel.ac.in/courses/117105079/
2. http://nptel.ac.in/courses/117104069/
3. http://nptel.ac.in/courses/117104020/

Course Outcomes (COs)

After completion of the course students should 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. Design image degradation models for different restoration techniques.
4. Analyze the different color models for Color Image Processing.
5. Demonstrate the basic concepts in Video Processing.
6. Compare the various Image and Video Compression Techniques.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code:522EP   **3 - - 3**

5G TECHNOLOGIES (PSE 3)

Prerequisites: Wireless Communications & Networks.

Course Objectives:
1. To understand the requirements & concepts of 4G/5G.
2. To expose the architecture and radio access technologies of 5G.
3. To learn Massive MIMO concepts.

UNIT 1: (~8 lecture hours)
Overview of 4G/5G Wireless Communications: Evolution of mobile technologies (1G-5G), 3GPP Releases & its key aspects,4G overview, Overview of 5G, three high level 5G usage scenarios (eMBB, URLLC, mMTC), Key capabilities & requirements, performance & efficiency indicators, 5G vs. LTE-A Comparison, 5G frequency bands, 5G Use cases.

UNIT 2: (~10 lecture hours)
5G Channel Access Techniques: Basic requirements of transmission over 5G, Modulation Techniques-generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques –non-orthogonal multiple accesses (NOMA), Sparse Code Multiple Access (SCMA) –Comparison of multiple access methods.

UNIT 3: (~10 lecture hours)
5G Architecture: Introduction: NG,MN 5G Architecture framework, Layered functionality, 3GPP 5G architecture, Non-Roaming 5G system architecture, overall RAN architecture, Functional Split Between NG-RAN and 5G Core Network.
5G NextGen core network: Modern network requirements, SDN architecture, NFV benefits and requirements, – NFV Reference Architecture

UNIT4: (~8 lecture hours)
Device-to-device (D2D) communications: use cases of D2D communication in Cellular networks, D2D in 5G: research challenges, Radio resource management for mobile broadband D2D.Multi-hop D2D communications for proximity and emergency services.

UNIT 5: (~10 lecture hours)
Massive Multiple-Input Multiple-Output (MIMO) Systems: Introduction to Multi-Antenna system,Theoretical background: MIMO requirement, MIMO vs massive MIMO, Massive MIMO benefits, single user and multi-user MIMO, capacity of MIMO for unknown CSIT, massive MIMO capacity, Massive MIMO OFDM transmitter employing digital precoding, analog beamforming and hybrid of digital precoding and analog beamforming.

Text Books:

1. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies" CRC Press, 2019. SuvraSekhar Das and Ramjee Prasad, "Evolution of Air Interface Towards 5G: Radio Access Technology and Performance Analysis", Gistrup, Denmark:River Publishers series in Communication, 2018.
2. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, **"**5G Mobile Communications", Springer publications-2016.
3. William Stallings "5G Wireless: A Comprehensive Introduction", Pearson Education, 2021.
4. AfifOsseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology" Cambridge University Press-2016.

Reference Books:

1. R. S. Kshetrimayum, "Fundamentals of MIMO Wireless Communications", Cambridge University Press, UK, 2017.
2. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks" first edition, John Wiley & Sons, 2015.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ee56/course.
2. https://onlinecourses.nptel.ac.in/noc21_ee102/course.

Course Outcomes (COs)

After the completion of the courseStudents will be able to

1. Recall the requirements and key functionalities of 4G LTEA/5G NR technology
2. Compare various channel access technologies, modulation techniques used in 5G wireless systems
3. Illustrate the architecture of 5G and its NextGen core network
4. Apply the 5G concepts to D2D communications
5. Demonstrate the concept of massive MIMO

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code:522EQ   **3 - - 3**

PRINCIPLES OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (PSE 4)

Prerequisite: -

Course Objectives:
1. To become familiar with basic principles of AI toward problem solving using Search Strategy.
2. To illustrate AI and ML algorithms and their use in appropriate applications.
3. To able to formulate solutions to real time problems using machine learning algorithms.
4. To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on advances.

UNIT 1: (~10 Lecture Hours)
Introduction: Definitions of AI, Foundations of AI, Subareas of AI.
Intelligent Agents: Agents and Environment, The Structure of Agents.
Solving Problems by Searching: Uninformed Search Strategies - Breadth-first search, Uniform-cost search, Depth-first search, Informed (Heuristic) Search Strategies, Greedy best-first search, A* search, Heuristic Functions, Hill climbing search.

UNIT 2: (~10 Lecture Hours)
Adversarial Search: Optimal Decisions in Games, The minimax algorithm, Alpha-Beta Pruning, Constraint Satisfaction Problems.
Bayesian Learning: Bayes theorem and concept learning, Maximum Likelihood and least square error Hypothesis, Minimum Description Length Principle, Bayes optimal classifier, Gibbs Algorithm, Naïve Bayes Classifier, Bayesian Belief Networks, The EM algorithm.

UNIT 3: (~8 Lecture Hours)
Introduction to Machine Learning: Examples of Machine Learning Applications, Learning Associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning.
Supervised Learning: Learning a Class from Examples, Vapnik-Chervonenkis Dimension, Probably Approximately Correct Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm.

UNIT 4: (~8 Lecture Hours)
Artificial Neural Networks: Introduction, Appropriate problems for NN learning, Perceptrons, Multilayer Networks and Backpropagation Algorithm, Remarks on Backpropagation Algorithm, An example: Face recognition, Advanced topics of ANN-Error functions, Recurrent Networks.

UNIT 5: (~12 Lecture Hours)

Decision Trees: Introduction, Univariate Trees, Classification Trees, Regression Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees, Problems on Decision Tree.

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. Stuart Rusell, Peter Norving, "Artificial Intelligence: A Modern Approach", Pearson Education 2nd Edition.
2. Tom M. Mitchell, "Machine Learning", Mc Graw Hill Education, 1997.
3. Ethem Alpaydin, "Introduction to Machine Learning", 3rd edition, 2014.

Reference Books:
1. Elaine Rich, Kevin K and S B Nair, "Artificial Intelligence", 3rd Edition, McGraw Hill Education, 2017.
2. Trevor Hastie, Robert Tibshirani& Jerome Friedman. "The Elements of Statistical Learning", Springer Series in Statistics, 2nd Edition 2001.
3. Chrishtopher M.Bishop, "Pattern Recognition and Machine Learning", ISBN-13: 978-0387-31073-2, Springer, 2006.

Online Resources:
1. https://www.routledge.com/rsc/downloads/AI_FreeBook.pdf (EBook: Explorations in AI and Machine Learning by Prof. Roberto V. Zicari).
2. https://nptel.ac.in/courses/106105077 (Course Title: Introduction to Artificial Intelligence, Prof. AnupamBasu, Prof. S. Sarkar, IIT Kharagpur).
3. https://nptel.ac.in/courses/106105077 (Course Title: Introduction to Machine Learning, Prof. S. Sarkar, IIT Kharagpur).

Course Outcomes (COs)

After completion of the course students should be able to:
1. Understand the basics of various search techniques and learning algorithms.
2. Apply various search algorithms for problem solving.
3. Analyze Bayesian Networks, Game playing and constraint optimization methods.
4. Compare neural network parameter optimization using Gradient descent optimization and compute error-function derivatives.
5. Analyze unsupervised, supervised and reinforcement learning.
6. Construct Neural Networks, Decision tree for problem solving.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code:522ER   **3 - - 3**

OPTICAL NETWORKING (PSE 4)

Prerequisite: Optical Communications.

Course Objectives:
1. To apply optical networking components for making communication.
2. To understand the features of SDHI and DWDM.
3. To evaluate cross talk in optical networks.
4. To implement Ethernet access optical network.

UNIT 1: (~8 Lecture Hours)
 Optical Networking: Introduction to circuit switching and packet switching, optical layer, Network evaluation, Optical networking components/building blocks: Optical fibers, Optical transmitter, receiver and filters, multiplexers, switching elements, wavelength Converter, and optical amplifiers.

UNIT 2: (~8 Lecture Hours)
Basic Optical networks: Client layers of the optical layer, WDM network elements, Basic networks: SONET/ SDH, Fault management, wavelength routed networks. Nonlinear effects on network performance, performance of various systems (WDM, DWDM +SOA).

UNIT 3: (~8 Lecture Hours)
Technologies and Topologies: Evaluation of crosstalk and dynamics in reconfigurable networks due to power transients and test Countermeasures. Technologies (CWDM, PON. ROADM, RSOA) and topologies of access, aggregation and distribution networks.

UNIT 4: (~10 Lecture Hours)
Optical Access networks: Photonic packet switching. Deployment considerations, Overview of PON technologies, Ethernet access network, WDM-PON, HFC Systems (Standards: CATV, VDSL), 10-Gigabit Ethernet (xGbE) (Standards: IEEE 802.3.aq).

UNIT 5: (~11 Lecture Hours)
Radio Over Fiber (ROF): Microwave Photonics and Radio-Over-Fiber (Standards: IEEE 802.11a/16b, 3GPP UTRAN etc.) including schemes for RF-over-Fiber systems carrying wireless formats such as   WiFi , WiMax , UMTS, LTE, PON and FTTH (Standards: ITU G 983 & G 984 and IEEE 802.3. ah). Control and management, network survivability, protection schemes.

Text Books:
1. Rajiv. Ramaswami , Kumar N. Sivarajan,Galen H.Sasaki Optical Networks 3rd edition, Elsevier, 2009.
2. C. Sivaramamurthy, M. Gurusamy, WDM Optical Networks, PHI,2002

Reference Books:
1. Rajiv Ramaswami and Kumar Sivarajan, Optical Networks: A practical perspective, Morgan Kaufmann, 2nd edition, 2001.
2. Vivek Alwayn, Optical Network Design and Implementation, Pearson Education, 2004.
3. Hussein T.Mouftab and Pin-Han Ho, Optical Networks: Architecture and Survivability, Kluwer Academic Publishers, 2002.
4. Biswanath Mukherjee, Optical Communication Networks, McGraw Hill, 1997.

Online Resources:
1. https://nptel.ac.in/courses/117101002
2. https://www.digimat.in/nptel/courses/video/108106167/L101.html

Course Outcomes (COs)

After completion of the course students should be able to:
1. Analyse the structure of the first generation networks and SONET.
2. Understand the salient features of WDM network architecture of the optical amplifiers.
3. Compare the merits and demerits of various wavelength Optical networks.
4. Appreciate optical switching, network evolution and components.
5. Evaluate performance of optical networks with non-linear effects.
6. Implement optical access networks and recent developments.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code: 522ES   **3 - - 3**

SOFTWARE DEFINED AND COGNITIVE RADIO (PSE 4)

Prerequisites: Digital Signal Processing, Analog and Digital Communications.

Course Objectives:
1. To provide fundamentals and state of the art concepts in Software defined radio.
2. To explore the principle of Cognitive radio.
3. To develop techniques for spectrum sensing.
4. To analyze models and techniques for efficient utilization of spectrum.

UNIT 1: (~11 Lecture Hours)
Introduction to Software Defined Radio: Introduction to Software Defined Radio, The Requirement for Software Defined Radio, The Benefits of Multi-standard Terminals, Operational Requirements, Business Models for Software defined radio, New Base-Station and Network Architectures, Smart Antenna Systems.
Basic Architecture of a Software Defined Radio: Software Defined Radio Architectures, Ideal Software Defined Radio Architecture, Required Hardware Specifications, Digital Aspects of a Software Defined Radio, Current Technology Limitations - A/D Signal-to-Noise Ratio and Power Consumption, Derivation of Minimum Power Consumption.

UNIT 2: (~11 Lecture Hours)
ADCs, DACs and Digital frequency up and down converters: Digital conversion fundamentals, ADC techniques, DACs, Frequency Converter fundamentals, DUCs, DDCs.
Software Architecture and Components: Major Software Architectural Choices, Software Standards for Software Radio.

UNIT 3: (~9 Lecture Hours)
Introduction to Cognitive Radios: Introduction, Definition of Cognitive Radios, The Cognitive Cycle, The Radio Scene Analysis, Dynamic Spectrum Access and Management, Regulatory Aspects, Application Clusters.
CR Architecture: Introduction, Cognitive Radio Network Architectures, Topology-Aware CRN Architectures, Publish-Subscribe CRN Architecture.

UNIT 4: (~8 Lecture Hours)
Fundamentals of Spectrum Sensing and Detection: Introduction, Statistical Detection Techniques, Continuous and Discrete Signal Detection, Detection Performance. Spectrum Sensing Techniques: Spectrum Sensing with Energy Detection, Energy detection and noise power uncertainty, Spectrum Sensing with Cyclostationary Feature Detection, Spectrum Sensing with Matched Filter Detection.

UNIT 5: (~9 Lecture Hours)
Localization and Radio Environment Mapping: Ranging Techniques and Enabling Technologies, Performance Limits of Time-based Ranging, Cognitive Ranging, Localization techniques, Localization of Non collaborative Emitters, Radio Environment Mapping.

GNU radio for cognitive radio experimentation: Introduction to GNU Radio, Software, Hardware, GNU Radio Resources, Cognitive Transmitter.

Text Books:

1. Paul Burns, Software Defined Radio for 3G, Artech House, 2002.
2. Peter B. Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House (June 30, 2005).
3. Kandeepan Sithamparanathan, Andrea Giorgetti, Cognitive RadioTechniques: Spectrum Sensing, Interference Mitigation, and Localization, Artech House (September 30, 2012).
4. Alexander M. Wyglinski, MaziarNekovee, and Thomas HouY,Cognitive Radio Communications and Networks-Principles and Practice, Academic Press; 1st Edition (December 8, 2009).

Reference Books:

1. Bruce Fette, Cognitive Radio Technology, Newnes, 2006.
2. Ekram Hossain, Dusit Niyato, Zhu Han, Dynamic Spectrum Access andManagement in Cognitive Radio Networks, Cambridge University Press, 2009.
3. Jeffrey H. Reed, Software Radio: A Modern Approach to Radio Engineering, PEA Publication, 2002.

Online Resources:

1. https://www.electronics-notes.com/articles/radio/sdr-softwaredefined- radio-receiver/sdr-basics.php
2. https://onlinecourses.nptel.ac.in/noc18_ec01/preview
3. http://www.telecomabc.com/c/cognitive.html

Course Outcomes (COs)

After completion of the course students should be able to:

1. Gain the fundamental concepts of Software defined radio.
2. Analyze the hardware and software architecture of Software defined radio.
3. Identify the limitations of ADCs and DACs.
4. Comprehend the concepts of Cognitive Radio.
5. Develop the Cognitive radio, as well as techniques for spectrum sensing.
6. Analyze various ranging and localization techniques for better spectrum exploitation.

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M.Tech. WMC I Year, II Sem.   **L T P   C**
Course Code:52275   **- - 3   1.5**

ADVANCED COMMUNICATIONS SYSTEMS LAB (PCL 3)

Course Objectives:
1. Understand the Spread Spectrum Systems concepts.
2. To study ATM technology in B-ISDN.
3. To understand basic requirements of MIMO systems.
4. To implement MIMO-OFDM system in modern wireless communications.

Experiments:
1. To study the operation of Direct - Sequence Spread Spectrum Modulation and Demodulation technique.
2. To study the operation of Frequency - Hopping Spread Spectrum Modulation and Demodulation technique.
3. To study the operation of CDMA in multi-user channel.
4. Implementation of matched filter.
5. OFDM Transceiver design using SDR
6. **ATM: A connection oriented cell switching technology**: Study the effect of Peak Cell Rate (per Sec) and Cell Delay Variation Tolerance on the performance of an ATM Networks. (Netsim)
7. **Applications: Network Applications, Performance and Analysis** Analyze the effect of different applications as data, CBR and VBR on network Performance (Netsim)
8. Measurement of effect of Inter Symbol Interference
9. To find MIMO Channel Capacity using Matlab.
10. Simulation of Alamouti coding using Matlab
11. Simulation of Pilot based channel estimation using Matlab.
12. Implementation of Linear multi user detection techniques using Matlab.
13. Measurement of PAPR in OFDM using Matlab.
14. Implementation of MIMO-OFDM using Matlab.

Online Resources:
1. http://nptel.ac.in/courses/117104099/
2. https://www.cse.wustl.edu/~jain/papers/ftp/atm_issues/index.html

Course Outcomes (COs)
After completion of the course students should be able to:
1. Implement CDMA Technique in multi-user environment.
2. Measure Peak Cell Rate (per Sec) and Cell Delay Variation Tolerance (CDVT) for ATM networks.
3. Analyze the effect of different class of services such as CBR and VBR on network Performance.
4. Measure channel capacity of MIMO system.
5. Design OFDM Transceiver using Software Radio.
6. Develop solutions to PAPR issue in OFDM systems.

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M.Tech. WMC I Year, II Sem.   **L T P   C**
Course Code:52276   **- - 3 1.5**

WIRELESS SENSOR NETWORKS LAB (PCL 4)

Prerequisite: Adhoc Wireless networks, Sensor networks, basics of programming.

Course Objectives:
1. Familiarize to get an exposure on working with real time sensor motes
2. Expertise to work with arduino and raspberry pi.
3. Introduce the students to upload sensor data to the internet.
4. Understand working with Tinkercad

Experiments
1. Program to make different patterns on built-in LEDs.
2. Program to acquire data from sensors.
3. Experimentation on Data aggregation of sensor data.
4. Program to detect a freely falling object.
5. Program to broadcast a string "Hello".
6. Program to unicast a message and get the acknowledgement.
7. Experimentation to analyze packet loss with varying distance, Indoor and outdoor.
8. Introduce to tinker cad and interface LEDs to Arduino
9. Program to acquire temperature, humidity of room and display on LCD using Arduino.
10. Program to implement automatic plant watering system.
11. Program to design automatic street light system.
12. Program to transfer sensor data wirelessly using arduino and Xbee.
13. Program to connect arduino to Thingspeak.
14. Program to acquire data on raspberry pi.
15. Program to connect raspberry pi to Thingspeak.

Instructions:
A. Minimum of 10 Experiments have to be conducted.
B. 1 to 7 are to be conducted on sensor motes.
C. 8 to 13 are to be conducted on Arduino boards.
D. 14 & 15 are to be conducted on raspberry pi.

Online Resources:
1. https://www.youtube.com/watch?v=CoJgQfRkqa4
2. https://development.libelium.com/waspmote-technical-guide/working-environment
3. https://www.tinkercad.com

Course Outcomes (COs)
After completion of the course students should be able to:
1. Acquaint with the knowledge of programming in EmbeddedC.
2. Exposure to the programming in simulation tool Tinkercad.
3. Understand the programming of Arduino and Raspberry pi.
4. Apply the skills required to upload sensor data to the Internet.
5. Design systems for real-time applications.

M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code: 521HC/522HC   **2 - - -**

SANSKRIT FOR TECHNICAL KNOWLEDGE
(Audit Course-2)

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 (Masculine Gender) – Streelingam (Feminine Gender) – Napumsaka lingam (Neutral Gender) – The forms of Nouns – Singular & Plural.

UNIT 2: (~ 6 Lecture Hours)
Pronouns & Demonstrative pronouns (Sarvanaama shabdaaha) 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 (Ramaha Raamou Raamaaha) – 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.

Reference Books:
1. "ABHYAAS PUSTAKAM", Dr. Vishwas, Samskrutha Bharati Publications, New Delhi.
2. Teach Yourself SANSKRIT, Prathama Deeksha by Vempati Kutumba Shastri, Rashtriya Sanskrit Sansthan, NewDelhi Publications.
3. "India's glorious Scientific Tradition", Suresh Soni, Ocean Books Pvt. Ltd., NewDelhi.

Course Outcomes:

After learning the contents of this course, the 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.
4. Relate the relevance of Sanskrit to Science and Technology.
5. Appreciate the conceptual understanding of Sanskrit to develop one's own competencies to understand, analyze and apply to sciences.
6. Identifying the similarities and differences to develop linguistic competency in learning a new language.

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M.Tech. WMC I Year, II Sem.   **L   T   P   C**
Course Code: 521HD/522HD   **2   -   -   -**

VALUE EDUCATION
(Audit Course-2)

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: (~ 7 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: (~ 6 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: (~ 6 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.

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

Online Resources:
1. http://nptel.ac.in/courses/109104068/36
2. http://nptel.ac.in/courses/109104068/37

Course Outcomes (COs)

After learning the contents of this course, the students will be able to

1.   Gain knowledge on self-development.
2.   Learn the importance of Human Values.
3.   Develop overall personality.
4.   Understand the importance of value education to build tolerance and harmony at different layers.
5.   Identify the ways for self-development.
6.   Identify the basic values and principles to guide one's own life.

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M.Tech. WMC I Year, II Sem.   **L T P C**
Course Code: 521HE/522HE   **2   -   -   -**

CONSTITUTION OF INDIA
(Audit Course-2)

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, PanchayatiRaj : 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.

Reference Books:

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

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

Course Outcomes:

After learning the contents of this course, the students will be able to

1. Tell about function of Indianc onstitution with clarity and understanding.
2. Identifythe Rights of equality, the Right off reedom and the Right to constitutional remedies
3. Mark the knowledge of union government & their powers and function.
4. Define the state and central policies, fundamental duties
5. Explain the powers and functions of Municipalities, Panchayats and Co-operative Societies
6. Discuss the Electoral Process, special provisions

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M.Tech. WMC I year, II Sem.   **L T P C**
Course Code: 521HG/522HG   **2 - - -**

STRESS MANAGEMENT BY YOGA
(Audit Course-2)

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: (5Asanas 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

- Bhramari Pranayama
- Nadanusandhana Pranayama.

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

Suggested Reading:
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.
10. Ravi Shankar N.S. (2001) Yoga for Health, New Delhi: Pustak Mahal.

Course Outcomes:
After learning the contents of this course, the 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.
5. Integrate Yoga into one's lifestyle.
6. Learn to practice the basic concepts of yoga to manage stress.

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M.Tech. WMC II Year, I Sem.   **L   T   P   C**
Course Code:523ET   **3   -   -   3**

VOICE OVER INTERNET PROTOCOL (PSE 5)

Prerequisites: Computer Networks.

Course Objectives:
1.   To provide detailed description regarding IPV4, IPV6 and RTP protocols.
2.   To inculcate knowledge about the challenges in the implementation of VOIP and new protocols developed for its implementation.
3.   To give an insight into QOS issues in VOIP and also it's internetworking with other existing internet protocols.

UNIT1: (~10 Lecture Hours)
Overview of IP Protocol Suite: The Internet Protocol, The Transmission Control Protocol (TCP), The User Datagram Protocol (UDP), The Real-time Transport Protocol (RTP), IP multicast, IP version 6 (IPv6), Interworking IPv4 and IPv6, The VoIP Market,   VoIP Challenges.

UNIT2: (~9 Lecture Hours)
H.323 and H.245 Standards: The H.323 Architecture, Call Signaling-Call Scenarios,H.245 Control Signaling Conference calls, The Decomposed Gateway.

UNIT3: (~8 Lecture Hours)
The Session Initiation Protocol (SIP): SIP architecture, Overview of SIP Messaging Syntax-Examples of SIP Message sequences, Redirect Servers, Proxy Servers, The Session Description Protocol (SDP), Usage of SDP with SIP.

UNIT4: (~9 Lecture Hours)
Media Gateway Control and the Softswitch: Separation of Media and Call Control, Softswitch Architecture, Requirements for Media Gateway Control, Protocols for Media Gateway Control, MGCP, The MGCP Model, MGCP Endpoints, MGCP Calls and Connections, Overview of MGCP Commands, Overview of MGCP Responses, Command and Response Details, Call Setup Using MGCP, MGCP Events, Signals and Packages, Internetworking between MGCP and SIP.
VOIP and SS7: Sigtran Architecture, Interworking SS7 and VoIP Architectures, Interworking Soft switch and SS7, Interworking H.323 and SS7.

UNIT5: (~10 Lecture Hours)
Quality of Service (QoS): Need for QOS, End-to-end QoS, Overview of QOS solutions, The Resource reservation Protocol (RSVP), Diffserv, The Diffserv Architecture, Multi- protocol Label Switching (MPLS), The MPLS Architecture, MPLS Traffic Engineering, Label Distribution Protocols and Constraint Based Routing.

Text Books:
1. Daniel Collins, "Carrier Grade Voice over IP", 2nd ed., TMH.
2. TCP/IP Protocol Suite- Behrouz A. Forouzan, 4th Edition, TMH.

Reference Books:
1. Nicholas Wittenberg , "Understanding Voice over IP Technology", Cengage, 1st Ed., 2010.
2. Michael, F. Finnevan, "Voice Over WLANS – The Complete Guide", Elsevier, 2008.
3. Thiagarajan Vishwanathan, "Telecommunication switching systems and networks" PHI publications, 2006.

OnlineReferences:
1. http://nptel.ac.in/courses/117105081/32
2. http://nptel.ac.in/courses/117101050/29

Course Outcomes (COs)
After completion of the course students should be able to
1. Understand various concepts related to IPV4, IPV6 and RTP.
2. Illustrate various challenges in the implementation of VOIP and modifications required to meet these challenges.
3. Analyze the architectures of in H.323, SIP and MGCP protocols developed for the implementation of VOIP.
4. Analyze the message formats used in H.323, SIP and MGCP Protocols.
5. Design protocols to ensure Quality of Service for VoIP.
6. Implement Internetworking of VOIP with already existing networks to attain required network performance.

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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code:523EU   **3 - - 3**

INDUSTRIAL IOT (PSE 5)

Prerequisite: Microcontroller and Embedded System Design.

Course Objectives:
The objectives of the course Industrial IoT are
1. To learn key IIoT concepts including sensors, actuators, communication protocols, data storage, and security.
2. To impart knowledge about various enabling technologies for IIoT, that links the automation system with enterprise, planning, and product lifecycle.
3. To realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices
4. To understand significant challenges ranging from technology, and architectural choices to security concerns and get insights on overcoming these challenges.
5. To study technological developments that will likely shape the industrial landscape in the future.

UNIT 1: (~8 Lecture Hours)
Introduction to IIoT: Sensors and actuators, Communication technologies, Networking technologies.
Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution in Industries.

UNIT 2: (~10 Lecture Hours)
Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems. IIoT Sensing, IIoT Actuating, IIoT Communication Models, IIoT Networking Technologies, IIoT Business Models, IIoT Reference Architecture, Smart and Connected Business Perspective.

UNIT 3: (~8 Lecture Hours)
Smart Factories Industry 4.0: Cyber-Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management.

UNIT 4: (~12 Lecture Hours)
Data Analytics in IIoT: Introduction, Big Data Analytics, Machine Learning, Artificial Intelligence and Data Science-R and Python Programming, Data management with Hadoop, Data Center Networks, Edge / Fog Computing, Cloud Computing in IIoT, Augmented Reality and Virtual Reality.

UNIT 5: (~10 Lecture Hours)
IIoT Application Domains: Factories and Assembly Line, Food Industry. Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Oil, chemical and pharmaceutical industry, Case Study: Applications of UAVs in Industries, Cyber Security in Industry 4.0.

Text Books:

1. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cybermanufacturing Systems", Springer, 2017.
2. Ismail Butun, "Industrial IoT: Challenges, Design Principles, Applications, and Security", Springer, 2020.
3. Zaigham Mahmood, "The Internet of Things in the Industrial Sector: Security and Device Connectivity, Smart Environments, and Industry 4.0", Springer, 2019.

Reference Books:

1. "Internet of Things - From Research and Innovation to Market Deployment", By Ovidiu& Peter, River Publishers Series.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
3. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
4. Inside the Internet of Things (IoT), Deloitte University Press.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview (Course Title: Introduction to Industry 4.0 and Industrial Internet of Things, Dr. SudipMisra, Professor, Department of Computer Science and Engineering, IIT Kharagpur).
2. https://www.coursera.org/learn/industrial-internet-of-things (Course Title: Industrial Internet of Things (IIoT), Dr. M. S. Krishnan, Accenture Professor of Computer Information Systems, Professor of Technology & Operations, University of Michigan).

Course Outcomes (COs)

After completion of the course students should be able to:

1. Understand the key techniques and theory behind Industrial Internet of Things.
2. Apply effectively the various enabling technologies (both hardware and software) for IIoT.
3. Carry out the integration of Cloud and IoT, Edge and Fog Computing.
4. Apply various techniques for Data Accumulation, Storage and Analytics.
5. Design and build IIoT system for any one interesting Use case.

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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code:523EV   **3 - - 3**

MULTIMEDIA COMMUNICATIONS (PSE 5)

Prerequisites: Image Processing, Signals and Systems.

Course Objectives:
1. Familiarize student, the history, applications of multimedia
2. Introduce different tools related to multimedia.
3. Build an Understanding of core multimedia technologies and standards (Digital Audio, Graphics, Video, data transmission/compression)
4. Make the student be aware of factors involved in multimedia systems performance, integration and evaluation.

UNIT 1: (~10 Lecture Hours)
Introduction to Multimedia: Definition of Multimedia, components of components, research trends in multimedia, multimedia & hypermedia, World Wide Web, Overview of multimedia tools, Multimedia authoring, Graphics/ image data types, and file formats.

UNIT 2: (~10 Lecture Hours)
Color in Image and Video: Color Science – Image Formation, Camera Systems, Gamma Correction, Color Matching Functions, CIE Chromaticity Diagram, Color Monitor Specifications, Out-of-Gamut colors, White point correction, XYZ to RGB transform, Transform with Gamma Correction, L*a*b* Color model.
Color models in images – RGB color model for CRT displays, Subtractive Color : CMY Color model, Transformation from RGB to CMY, Under color removal : CMYK System, printer Gamuts.
Color models in video – Video Color Transforms, YUV color model, YIQ color model, YCbCr Color Model.

UNIT 3: (~8 Lecture Hours)
Fundamental Concepts in Video and Audio: Basics of Video: Types of video signals, Analog video, Digital Video, HDTV.
Basics of digital audio: Digitization of sound, Nyquist Theorem, SNR, SQNR, Linear & nonlinear quantization, audio filtering, audio quality vs data rate, synthetic sounds, quantization and transmission of audio.

UNIT 4: (~10 Lecture Hours)
Compression Algorithms:
Lossless Compression Algorithms: Run length coding, Variable length coding, Arithmetic coding, Lossless JPEG, Image Compression.
Lossy Image Compression Algorithms: Transform Coding:- KLT and DCT Coding, Wavelet based coding.
Image Compression Standards: JPEG and JPEG 2000

UNIT 5: (~10 Lecture Hours)

Video Compression Techniques: Introduction to Video Compression, Video Compression based on Motion Compensation, Search for motion vectors, H.261- Intra-frame and Inter-frame coding, Quantization, Encoder and Decoder, Overview of MPEG1.

Audio Compression Techniques: ADPCM in Speech Coding, G.726 ADPCM, Vocoders – Phase Insensitivity, Channel Vocoder, Formant Vocoder, Linear Predictive Coding,

Text Books:
1. Fundamentals of Multimedia – Ze- Nian Li, Mark S. Drew, PHI, 2010.
2. Multimedia Signals & Systems – Mrinal Kr. Mandal Springer International Edition 1st edition, 2009

Reference Books:
1. Multimedia Communication Systems – Techniques, Stds & Networks K.R. Rao, Zorans. Bojkoric, Dragorad A.Milovanovic, 1st Edition, 2002.
2. Multimedia Systems John F. KoegelBufond Pearson Education (LPE), 1st Edition, 2003.
3. Digital Video Processing – A. Murat Tekalp, PHI, 1996.
4. Video Processing and Communications – Yaowang, Jorn Ostermann, Ya-QinZhang, Pearson, 2002

Online References:
1. https://onlinecourses.nptel.ac.in/
2. https://www.coursera.org/

Course Outcomes (COs)

After completion of the course students should be able to:
1. Understand the basic taxonomy and terminology of the history, applications of multimedia
2. Understand image/graphics data types and file formats.
3. Illustrate the concepts of analog and digital video.
4. Exposure to the types of video signals and digitization of audio signals
5. Apply multimedia technologies and standards for image compressions.
6. Differentiate various audio and video compression standards.

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M.Tech. WMC II Year, I Sem.	**L**	**T**	**P**	**C**
Course Code: 523GA	**3**	**-**	**-**	**3**

BUSINESS ANALYTICS
(Open Elective -1)

Prerequisites: -NIL**-**

Course Objectives:
1. To understand the role of business analytics within an organization.
2. To gain and 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: (~ 8 Lecture Hours)
Introduction to Business Analytics

Introduction to Analytics - Importance of Analytics in Problem Analytics - Business Analytics - Importance - Difference between Business Analytics and Business Intelligence - Evolution of Business Analytics - Types of Business Analytics - Characteristics - Goals - Domains of Business Analytics - Framework of Business Analytics - Analytics Ecosystem - Process - advantages - steps of Decision modeling for Business Analytics.

UNIT 2: (~ 9 Lecture Hours)
Organization Structure and Data for Business Analytics

Organization Structure of Business Analytics - Functional organization - Matrix - centralized structure with Business Analytics - Factors determining in choosing appropriate structure - Reasons for organizational failure for Business Analytics Initiatives - Team Management - Reasons for Team failure.

Data - Characteristic of Readiness of data Dimensions - Data taxonomy - Data mining - process - Implications of Data outlines-Steps in data driven decision making - Importance of sampling - Data visualization - Types Data Storytelling - Data Journalism - Data warehousing.

UNIT 3: (~ 10 Lecture Hours)
Descriptive Analytics

Introduction to Descriptive Analytics, Measure of Central tendency-Mean, Median, Mode Measure of Variation-Variance, Standard deviation, Mean Deviation, Interquartile Deviation Measure of Shape-Kurtosis, Skewness, Measure of Association-Covariance, Correlation.

Random Variables: Discrete probability Distribution and Continuous Probability Distribution (Mean, Median, Mode).

UNIT 4: (~ 10 Lecture Hours)

Predictive and Prescriptive Analytics

Predictive Analytics- Regression- Simple linear regression, Multiple linear regression-Test of significance of regression coefficients Using ANOVA (one way and twoway classification), Coefficient of Determination. Forecasting -Time Series Analysis- Trend Analysis, Moving Average Method, ARMA Model with error Analysis.

Prescriptive Analytics: Linear Programing Problem- Graphical Method, Simplex Method.

UNIT 5: (~ 8 Lecture Hours)

Decision Analysis

Problem Formulation, Decision analysis without probabilities, Decision analysis with probabilities, Decision Analysis with sample information, Computing Branch Probabilities with Bayes Theorem, Utility Theory.

Text Books:
1. Ramesh Sharada, DursunDelen, Efraim Turban, David King: Business Intelligence, Analytics, and Data Science - A Managerial Perspective: Pearson: 4th Edition.
2. U Dinesh Kumar: Business Analytics - The Science of Data-Driven Decision Making: Wiley, 2nd Edition.

Reference Books:
1. Gert H.N. Laursen, Jesper Thorlund: Business Analytics for Managers - Taking Business Intelligence Beyond Reporting: Wiley 2nd Edition.
2. Camm, Cochran, Fry, Ohlmann, anderson, Sweeney, Williams: Essentials of Business Analytics: Cengage Publishers.

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

Course Outcomes:

After completion of the course, students will be able to:
1. Understand and apply business analytics in real time world.
2. Comprehend the structure of an organization for business analytics implementation.
3. Identify the befitting descriptive tool required for the business problem.
4. Apply suitable predicative method that supports business decision making.
5. Identify appropriate prescriptive modeling techniques for decision making.
6. Translate data into clear, actionable insights in the decision-making process.

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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code : 523GB   **3   - - 3**

INDUSTRIAL SAFETY
(Open Elective -1)

Prerequisites: Industrial Management.

Course Objectives:
The purpose of this course is to teach the students.
1. Concepts of industrial safety and provide useful knowledge for work place safety.
2. Understand Industrial Safety Programs, Fire explosions and its Preventive methods.
3. Helps in identification, evaluation and control of the hazards.
4. Mitigate harm to people, property and the environment.
5. Quality maintenance process, Duties & Responsibilities of Safety officer's.
6. Overhauling of Mechanical & Electrical machinery components, difference between Periodic & Preventive Maintenance.

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.

UNIT 2: (~ 10 Lecture Hours)
Accidents: causes, types, results and control, mechanical and electrical hazards types, causes and preventive steps, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water, lights, cleanliness fire guarding etc. safety colour code, fire prevention and fire fightingequipments and methods.

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

UNIT 4: (~ 8 Lecture Hours)
Quality and safety in maintenance: needs for quality maintenance process, maintenance work quality, use of quality control, 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: (~ 10 Lecture Hours)
Types of maintenance: corrective, breakdown, predictive, replacement, preventive and proactive maintenance.
Periodic and preventive maintenance in details: Periodic maintenance: inspection- concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motors, common troubles and remedies of electric motor, repair complexities and its use
Preventive maintenance: definition, needs, steps and advantages.

Text Books:
1. 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:
Students after completing this course would 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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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code: 523GC   **3 - - 3**

OPERATIONS RESEARCH
(Open Elective -1)

Prerequisites:-

Course objectives:
The course will enable the students to:
1. Study the linear programming and nonlinear 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 Research: 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: (~10 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: (~10 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 4: (~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.

UNIT 5: (~ 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.

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. IOR Tutorials (Interactive Operations Research Tutorial).
2. onlinecourses.nptel.ac.in.

Course Outcomes:

At the end of the course students are expected to:
1. Apply linear programming models to several Engineering Applications.
2. Solve selected models in Dynamic Programming practical applications.
3. Apply simple mathematical models in Inventory into the real Engineering Applications.
4. Solve Game theory problems related to business applications.
5. To minimize waiting time of the customer and optimization of number of servers.
6. Able to apply the concept of non-linear programming models to various engineering applications.

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M.Tech. WMC II Year, ISem.   **L T P C**
Course Code: 523GD   **3 - - 3**

COST MANAGEMENT OF ENGINEERING PROJECTS
(Open Elective -1)

Prerequisites: -NIL-

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: (~8 Lecture Hours)
INTRODUCTION TO PROJECT MANAGEMENT

Project - Need of Project Management - Objectives – Scope - Importance of Project Management - Principles of Project Management - Types of Projects -Roles and Responsibilities of Project Team.

UNIT 2: (~ 9 Lecture Hours)
PROJECT PLANNING AND IMPLEMENTATION

Project Management Life Cycle - Process-Project Selection – Feasibility study: Types of feasibility - Steps in feasibility study - Estimation of Project cost – Cost of Capital – Project Representation and Preliminary Manipulations – Basic Scheduling Concepts - Resource Levelling – Resource Allocation-Execution.

UNIT 3: (~ 8 Lecture Hours)
COST MANAGEMENT FOR PROJECTS

Introduction and importance of Cost Management for Projects - Objectives of Costing System - Various cost concepts - 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).

UNIT 4: (~ 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 (Simple Problems on Functional based budget). Introduction to Zero based budgeting.

UNIT 5: (~ 10 Lecture Hours)
PROJECT-COST MANAGEMENT

Project Cost Estimation - Project Financing - Project Planning and Scheduling - Project Cost Control - Quantitative Techniques for Project Cost Management - Linear Programming - Network Analysis - PERT/CPM - Project Cost Analysis - Transportation Model - Assignment Model (Simple Problems) – Simulation - Learning Curve Theory - Project Methodologies -Types - Project Integrated Management (PIM).

Text Books:
1. K.Nagarajan., Project Management, New Age International Publishers.
2. L.S.Srinath , PERT and CPM Principles and Applications.
3. Charles T. Horngren and George Foster, Cost Accounting: A Managerial Emphasis, PHI, 1st Edition.

Reference Books:
1. Arun Kanda, Project Management A Life Cycle Approach, Prentice Hall of India, 2011
2. R.B.Khanna, Project Management, Prentice Hall of India, 2011.
3. R.Panneerselvam and P.Senthilkumar, Project Management, Prentice Hall of India, 2009.
4. Blocher, Chen, Cokins, and Lin, Cost Management: A Strategic Emphasis.
5. John K. Shank and Vijay Govindarajan, Strategic Cost Management.

Online Resources:
1. http://nptel.ac.in/courses/110101004/24

Course Outcomes:
After completion of the course, students will be able to:
1. Perceive the cost associated in managing engineering projects.
2. Develop Project Planning proposal considering time and cost.
3. Furnish effective cost management practices for better handling of engineering projects
4. Prepare budgets for engineering projects.
5. Propose the Quantitative Techniques for Project Cost Management.
6. Orient the cost management decision-making using quantitative methodology in minimizing the cost associated with the projects.

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M.Tech. WMC II Year, I Sem.   **L   T   P   C**
Course Code : 523GE   **3   -   -   3**

COMPOSITE MATERIALS
(Open Elective -1)

Pre-requisites: Nil

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 Behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT 3: (~ 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 andprepregs – 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. R.W.Cahn – VCH, Material Science and Technology – Vol 13 – Composites, West Germany.
2. R. Balasubramaniam, Callister's Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian Edition, 2007.

Reference books:

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

Web 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:

After completion of the course, students will be able to

1. Differentiate composite materials and their applications.
2. 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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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code : 523GF   **3 - - 3**

ENERGY FROM WASTE
(Open Elective)

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.

UNIT 1: (~ 8 Lecture Hours)

Classification of waste – Agro based, Domestic, Bio-Medical, Forest residue, Industrial waste, recycling of waste, Segregation of waste, waste treatment, Environmental impacts. Land fill method for disposal of waste, Land fill classification.
Guidelines for Minimization of Wastage in Society (Individual houses, Apartments, Industries etc.)-Reduce, Reuse & Recycle. Minimization of all types of wastage through Orientation programs, Awareness camps, workshops, seminar etc.
Group Discussion Activity(~2 Lecture Hours).

UNIT 2: (~9 Lecture Hours)

Biomass: Pyrolysis – Byproducts of Pyrolysis – Manufacture of pyrolytic oils and gases, applications. Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation Concepts of Gasifier Arrangements, Burner and Engine arrangements for electric power generation.

UNIT 3: (~ 8 Lecture Hours)

Biomass Combustion: Biomass stoves – Improved challahs, 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), 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: (~ 7 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.

NOTE: A classroom activity such as Group Discussion involving all students to be conducted on the topics given in the second half of first unit.

Text Books:

1. Desai, Ashok V., "Non-Conventional Energy" Wiley Eastern Ltd., 1990.
2. Challal, D.S., " Food, Feed and Fuel from Biomass" IBH Publishing Co.Pvt.Ltd.,1991.
3. Nicholas P. Cheremisinoff. " Handbook of Solid Waste Management and Waste Minimization Technologies" An Imprint of Elsevier, New Delhi, 2003.
4. T.V. Ramachandra, Management of Municipal Solid Waste, The Energy and Resources Institute, TERI, 2009.

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. Khandelwal, K.C. and Mahdi S.S. "Biogas Technology - A Practical Hand Book Vol.I& II," Tata McGraw Hill Publishing Co.Ltd.' 1983.

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.
6. Understand and adapt Waste minimization techniques as a societal responsibility.

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M.Tech. WMC II Year, I Sem.   **L T P C**
Course Code : 523GG   **3 - - 3**

POWER FROM RENEWABLE ENERGY SOURCES
(Open Elective)

Prerequisites: NIL

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.

Online Resource: https://nptel.ac.in/courses/103103206

Course Outcomes:
After completion of this course, the student 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.
6. Suggest suitable methods of power generation for a particular region/ organization based on the availability of resources.

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PROGRAM EDUCATIONAL OBJECTIVES:

PEO-1:	Apply Wireless and mobile communication concepts to solve the real world problems in industry, academics and research.
PEO-2:	Exhibit Professional competence and leadership with human values and ethics leading to an integrated personality development.
PEO-3:	Innovate and Contribute in diverge areas including RF, Signal Processing and Computational Engineering.
PEO-4:	Adapt to Technical changes through lifelong learning for global acceptance.

PROGRAM OUTCOMES – M.TECH. (WMC)

PO1	An ability to independently carry out research/investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to work in a team to take up the projects in domain specific and multidisciplinary areas with due consideration to societal ,environmental, economical and financial factors.
PO5	An ability to maintain lifelong learning and research by way of participating in various professional activities with a higher level of commitment.

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

INSTITUTE VISION

To become a center of quality education in Engineering and Technology for women empowerment.

INSTITUTE MISSION

- To fulfill the academic aspirations of women engineers for enhancing their intellectual capabilities and technical competency.

- To Leverage Leading – Edge Technologies and cultivate exemplary work culture.

- To facilitate success in their desired career in the field of engineering to build a progressive nation.

INSTITUTE QUALITY POLICY

G. Narayanamma Institute of Technology and Science (For Women), Hyderabad is committed in imparting Quality Education and Training for women empowerment in the field of "Engineering and Technology" and to satisfy applicable requirements through continual improvement of the Quality Management System by facilitating and supporting the staff and students to work as a team in upgrading their knowledge and skill in tune with the industrial and technological developments through a set of Quality objectives.