Important Academic Rules
M.Tech. Degree Programme
In
Electronics & Communication Engineering

GENERAL

- The Regulations may evolve and get revised/refined or updated or amended or modified or changed through approvals from the Academic Council from time to time, and shall be binding on all parties concerned, including the Students, Faculty, Staff, Departments, University Authorities and officers. Further, any legal disputes shall be limited to the legal jurisdiction determined by the location of the University and not that of any other parties.
- If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the matter will be reported to the AC, recommending revoking the admission of the candidate.
- The LU reserves the right to cancel the admission of any student at any stage of his study programme in the University on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.
- Medium of Instruction shall be English.

PROGRAMME

- For full-time students, the duration of study shall be a minimum of Six Terms and a maximum of FOUR years. For part-time students, the duration will be a minimum of Nine Terms and a maximum of FIVE years.
- There are three types of student status in the M.Tech. Degree Programme:
  (a) Full-time student of GATE-Scholarship (FTG)
  (b) Full-time/Part-time sponsored student from Industry or other Organizations including Educational Institutions (FTS/PTS)
  (c) Full-time/Part time non-sponsored non-scholarship student (FTN/PTN)
- The course content for an M.Tech. Degree Programme will typically consist of the following components.
  (a) Two-Letter Grade Courses
    (i) Compulsory Courses
    (ii) Programme Core Courses
    (iii) Elective Courses*
    (iv) Dissertation

  (b) Non-Two-Letter Grade Courses
    (i) Seminar
    (ii) Teaching Practice
  * Some electives may be pre-requisite for another elective course.
- The exact credits offered for the programme for the above components, the term-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department are given in the 'Scheme of Studies and Syllabus'.
- The minimum credit requirement for the M.Tech. Degree is 90.

DISSERTATION

- The Dissertation carries 11 credits and spreads over THREE Terms, (normally during 4^{th} to 6^{th} Terms for full time and 7^{th} to 9^{th} Terms for part time students or as recommended by BOS). The progress of the Dissertation shall be monitored by the guide.
- Under special circumstances a student can be allowed to undertake dissertation work in industry/research laboratory/other University. The place of work has to be approved by AC.
- A candidate shall submit 5 copies of the Dissertation duly recommended by the guide after assessment by the committee to the Chairman, DEC, on or before the specified date. The Report shall be in the format prescribed by the University.
- The earliest date for the submission of dissertation shall be three weeks before the closure of the trimester in which the dissertation work credits have been registered for, and is expected to be completed, or as announced by the DAA.
- Extension of time beyond the announced last date for submission of the Dissertation may be granted by the DAA on recommendation from the HOD.
- The final evaluation is done by a Dissertation Evaluation Committee (DEC) constituted by the pertinent BOS. There shall be an open seminar followed by a viva-voice examination as part of the final evaluation. After the final evaluation, appropriate double-letter grade is recommended to DAA, for necessary action.
- If in the opinion of DEC, the Dissertation needs some minor modifications DEC will report to DAA along with recommended grade. The DAA shall instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, DEC. After such resubmission, the chairman, DEC will certify that the necessary modifications have been incorporated and recommend to DAA for the acceptance and award of the grade as recommended by DEC.
- The title of the Dissertation shall be indicated in the Transcript.
- The dissertation grades will be considered for TGPA and CGPA calculation.

NON TWO-LETTER GRADE COURSES

- These are courses that must be completed by the student at appropriate time as suggested by the Faculty Advisor. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. In case 'N' grade is awarded, the student has to

re-register for the same course wherein he has no alternative options. However, he can opt for other courses if he has been provided with multiple options. The 'S' and 'N' grades do not carry grade-points and hence not included in the TGPS, CGPS computations.

ASSOCIATION

- Every Post Graduate student of the University shall be associated with the Parent Department, throughout his study period.
- The schedule of academic activities for a term, including the dates of registration, mid-term examinations, end-term examination, inter-term vacation, etc. shall be referred to as the Academic Calendar of the term, and announced at least two weeks before the closing date of the previous term.

PRE-REGISTRATION

- In order to facilitate proper planning of the academic activities of a term, it is essential for the students to declare their intent to register for a course well in advance, before the actual start of the academic session, through the process of Pre-Registration, which is mandatory for all those students of second or subsequent term who propose to deviate from recommended scheme of studies.
- Pre-registration is an expression of intention of a student to pursue particular course(s) in the next term. It is an information for planning for next term. Every effort will be made to arrange for a course opted by the student. However, it is not obligatory on the part of the university to offer the course(s) and no course may be offered if the number of students opting for the course is less than 15 or 25 percent of the admission strength whichever is less.
- If a student fails to pre-register it will be presumed that he will follow suggested normal scheme of studies provided that he is progressing at a normal pace. For remaining students the HOD of the parent department will plan for courses as per the convenience of the department.

REGISTRATION TO COURSES

- Every Student after consulting his Faculty-Advisor is required to register for the approved courses with the HOD of parent department at the commencement of each term on the days fixed for such registration as notified in the academic calendar.
- A student shall register for courses from amongst the courses being offered in the term keeping in mind the minimum and maximum credits allowed for a degree and other requirements i.e. pre-requisite, if any, TGPA & CGPA after consulting the Faculty Advisor. No registration will be valid without the consent of HOD of the parent department.
- A student will be permitted to register in the next term as per the suggested normal scheme only if he fulfills the following Conditions:
  (a) Satisfied all the Academic Requirements to continue with the programme of studies without termination.
  (b) Cleared all university, library and hostel dues and fines (if any) of the previous term.

  (c) Paid all required advance payments of the university and hostel for the current term.
  (d) Not been debarred from registering on any specific ground by the university.
- The students will be permitted to register for course(s) being offered in a term other than his normal suggested scheme provided that the time table permits.
- The registration in the critical cases will be done as per the priority given below:
  (a) Fulfillment of minimum credit requirement for continuation,
  (b) The completion of programme in minimum period needed for degree, (Those who need to improve TGPA/CGPA)
  (c) The fulfillment of pre-requisite requirement of courses.
- Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
- REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the DAA after the recommendation of HOD through the guardian of the student.
- Credits will be awarded in registered courses only.

TEACHING PRACTICE

- A Student is required to do two courses (one one-credit course and the other a two–credit course) for Teaching Practice under the guidance of HOD. Here the student is required to be engaged in teaching of two UG courses of his choice each for two hours per week in any of the two terms during the programme.

REGISTRATION- REVISION

- A student has the option to ADD courses for registration till the date specified for late registration in the Academic Calendar.
- On recommendation of the Teaching Department as well as the Parent Department, a student has the option to DROP courses from registration until two weeks after the commencement of the classes in the term, as indicated in the Academic Calendar.
- A student can register for auditing a course, or a course can be converted from credit to audit or from audit to credit, with the consent of the Faculty Advisor and Course Instructor within two weeks after the commencement of the classes in the term as indicated in the Academic Calendar. However, CORE Courses shall not be available for audit.

ATTENDANCE REQUIREMENTS

- LU academic programmes are based primarily on the formal teaching-learning process. Attendance in classes, participating in classroom discussions and participating in the continuous evaluation process are the most essential requirements of any academic programme.
- Attendance will be counted for each course scheduled teaching days as per the academic calendar.
- The attendance requirement for appearing in end term examination shall be a minimum of 75% of the classes scheduled in each course.

LEAVE OF ABSENCE

- The leave of absence must be authorized as per regulations.
- A student short of attendance in a course (less than needed after leave of absence and condonation by VC) will be awarded 'FF' grade in the course.
- All students must attend all lecture, tutorial and practical classes in a course. The attendance will be counted course wise.
- To account for approved leave of absence e.g. representing the University in sports, games or athletics; professional society activities, placement activities, NCC/NSS activities, etc. and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes scheduled in each course to appear in the examination.
- A student with less attendance in a course during a trimester, in lectures, tutorials and practicals taken together as applicable, shall be awarded 'FF' grade in that course, irrespective of his academic performance, and irrespective of the nature of absence.
- If the period of leave is more than three days and less than two weeks, prior application for leave shall have to be submitted to the HOD concerned, with the recommendation of the Faculty-Advisor, stating fully the reasons for the leave requested, along with supporting documents.
- If the period of leave is two weeks or more, prior application for leave shall have to be made to the DAA with the recommendations of the Faculty-Advisor, HOD concerned stating fully the reasons for the leave requested, along with the supporting documents. The DAA may, on receipt of such application, grant leave or decide whether the student be asked to withdraw from the course for that particular term because of long absence.
- If a student fails to apply and get sanction for absence as in (a) and (b) above, his parent/guardian may apply to the VC with reasons duly recommended by the faculty advisor, HOD and DAA and explain in person to the VC the reasons for not applying in time. The VC will consider on merit and decide to grant the leave or withdrawal from the course for that particular term subject to any condition that he may like to impose. The decision of the VC shall be final and binding.

ABSENCE DURING EXAMINATIONS

- A student who has been absent during Mid-term Examination due to illness and/or any exigencies may give a request for make-up examination within one week after the Mid-term Examination to the HOD with necessary supporting documents in person. The HOD may consider such requests depending on the merits of the case, and after consultation with the course instructor, may permit the Make-up examination for the Student concerned. However, no makeup examination will be permitted if the attendance in the course is less than 60% till the date of examination.
- In case of absence from End-term Examination of a course(s) on Medical ground and/or other special circumstances, the student can apply for award of 'I' grade in the course(s) with necessary supporting documents and certifications by an authorized person to the HOD within one week

after the End-term Examination. The HOD may consider the request, depending on the merit of the case, and after consultation with the Course(s) Instructor(s)/ faculty advisor permit the MET Examination for the student concerned. The student may subsequently complete all course requirements within the date stipulated by BOS (which may possibly be extended till first week of trimester under special circumstances) and 'I' grade will then be converted to an appropriate Double-letter grade, as per Clause No: G5.9. All the details of such a decision with date of finalizing the grade shall be communicated to DAA. If such an application for the 'I' grade is not made by the student then a double-letter grade will be awarded based on his term performance.

COURSE CREDIT ASSIGNMENT

- Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The credits for various courses are shown in the Schemes of Studies & syllabus.
- The Academic Performance Evaluation of a Student shall be according to a Letter Grading System, based on the Class Performance Distribution.
- The double-letter grade (AA, AB, BB, BC, CC, CD, DD, FF) indicates the level of academic achievement, assessed on a decimal (0-10) scale.

Letter-Grades and Grade-Points:

LETTER-GRADE	GRADE-POINTS	REMARKS
AA	10	
AB	9	
BB	8	
BC	7	
CC	6	
CD	5	
DD	4	
FF	0	Fail
I	-	Incomplete
U	-	Audited
W	-	Withdrawal
S	-	Satisfactory
N	-	Unsatisfactory

DESCRIPTION OF GRADES

- An 'AA' grade stands for outstanding performance, relative to the class which may include performance with previous batches. The Course Instructor is supposed to take utmost care in awarding of this highest double-letter grade.
- The 'DD' grade stands for marginal performance and is the minimum passing double-letter grade.
- The `FF grade denotes very poor performance, i.e. failure in a course, and the Course Instructor is supposed to take utmost care while awarding this lowest double-letter grade.

- A student, who obtains 'FF' grade in a core course, has to repeat (re-register) that core course, in subsequent trimesters/sessions whenever the course is offered, until a passing grade is obtained. However, for an elective course in which 'FF' grade has been obtained, the student may either repeat the same course, or register for any other elective course.
- An 'I' grade denotes incomplete performance in any course due to absence at the end term examination (see also Clause No: G7.4). When the 'I' grade is converted to a regular double letter grade, a penalty of ONE Grade-Point is imposed, by awarding the double-letter grade that is immediately below the one that the student would have otherwise received except when the student has 95% attendance record in the subject concerned. For example, if on the basis of the performance including MET Examination, a student gets AB grade, he hill be awarded BB grade if not under exception rule.
- 'U' grade is awarded in a course that the student opts to register for audit. It is not mandatory for the student to go through the entire regular process of evaluation in an audit course. However, the student has to go through some process of minimal level of evaluation and also the minimum attendance requirement, as stipulated by the Course Instructor and approved by the corresponding BOS, for getting the 'U' grade awarded in a course, failing which that course will not be listed in the Grade Card.
- A 'W' grade is awarded when the student withdraws from the course. Withdrawal from a course is permitted only under extremely exceptional circumstances (like medical emergencies, family tragedies and/or other unavoidable contingencies) and has to be recommended by the HOD and approved by the DAA. However, no withdrawal is permitted after the finalization of the grades in the term.
- 'S'/'N' These grades are awarded for the Mandatory Learning Courses. The 'S' grade denotes satisfactory performance and completion of a course. The `N' grade is awarded for non- completion of course requirements and the student will have to register for the course until he obtains the 'S' grade.

FEEDBACK TO STUDENTS

- A student requires feedback on the progress of his learning. For this purpose, the Instructor will conduct at least two quizzes for a theory course in a term-one before Mid-term Examination and the other there after. The quizzes will form a component of class work, the other components being tutorials, home assignments or any other mode.
- For a laboratory course, the continuous assessment's feed back will be given through the laboratory records which are required to be submitted after performing the experiment in the next laboratory class.

EVALUATION

- The double-letter grade awarded to a student in a course other than a practical course i.e. 0-0-P course for which he has registered, shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to one mid-term examination and end-term examination. The weightage of these components of continuous evaluation may be as follows:

End-term Examination	:	50%
Mid-term Examinations	:	30%
Quizzes, Tutorials, Assignments, etc. (Several over the term)	:	20%
Total	:	100%

- The double letter grade awarded to the student in a practical course i.e. 0-0-P course will be based on his performance in regular conduct of experiments, viva voce, laboratory report, quizzes etc., in addition, to term practical examination. The weightage of the components of continuous evaluation may be as follows:

Conduct of Experiments (as per syllabus)	:	40%
Lab Record	:	10%
Quizzes/Viva Voice	:	20%
End-term Examination	:	30%
Total	:	100%

- The University shall conduct the End-term examination for all theory courses being taught in the term.
- The answer books of all Mid-term Examination and End-term Examination will be shown to the students within three days of the last paper. It is the responsibility of the student to check this evaluation and affix his signature in confirmation.
- If the student finds some discrepancy, he should bring it to the notice of the Course Coordinator. The Course Coordinator will look into the complaint and remove the doubts of the student and proceed with the work of grading.
- If a student is not satisfied with the award of the grade after the announcement of the grades, he may appeal on a Grievance Form duly filled in along with the fee receipt for this purpose to the HOD of the parent department within one week of the following term. The HOD will forward the form along with his recommendation based on the records of the case to DAAB within the date specified in the Academic Calendar.

SCHEME OF EXAMINATION

- The duration of examinations for a theory course will be 3 hours for end-term examination 1½ hours for mid-term examination.
- The pattern of question paper/examination will be as under:
- **Theory Courses:**
  The University shall conduct the End-term examination for all theory courses being taught in the term.
  (a) There will be eight questions in all distributed over all the units in a course syllabus. The question paper will be in three parts with weightage 20 percent, 40 percent and 40 percent respectively.
  (b) Part-A will be short answer type with multiple parts covering all the units in the syllabus, which will be compulsory.
  (c) Part-B will have three questions from any three units, which will have long answers of derivation/descriptive type. Two questions are to be answered from this part.
  (d) Part-C will consist of four questions from the remaining four units and they will be of problem solving type in order to measure

ability on comprehension /analysis /synthesis / application. The relevant data will be made available. The student is required to solve two questions. However, for Part-C, the external examiner may select the questions from the question bank supplied by LU.

- Students are allowed in the examination the use of single memory, non-programmable calculator. However, sharing of calculator is not permitted.
- **Laboratory Courses:**
  (a) The End-term Examination in laboratory course will be conducted jointly by an external examiner (other than the instructor) and an internal examiner (the coordinator / instructor) jointly.
  (b) The student will be given randomly an experiment to perform from within the list of experiments in the course.
  (c) No change in the experiment will be permitted after the draw, if the student had performed the same in the class.
- **Mid-Term Examination:**
  Question 1 is compulsory covering all topics taught till then. Question 2 and 3 will be essay type, out of which student will answer any one. Question 4 and 5 will be to measure to ability of analysis / comprehension / synthesis / application. The student will answer any one.

TRANSPARENCY

- The answer books of all Mid-term Examination and End-term Examination will be shown to the students within three days of the last paper. It is the responsibility of the student to check this evaluation and affix his signature in confirmation.
- If the student finds some discrepancy, he should bring it to the notice of the Course Coordinator. The Course Coordinator will look into the complaint and remove the doubts of the student and proceed with the work of grading.
- The entire process of evaluation shall be transparent, and the course instructor shall explain to a student the marks he is awarded in various components of evaluation.

RESULT

- The final marks shall be displayed on the notice board for ONE day, (the date of which will be indicated in the academic calendar). A student can approach the concerned course instructor(s) for any clarification within Two days of display. The process of evaluation shall be transparent and the students shall be made aware of all the factors included in the evaluation. In case of any correction, the course instructor shall have to incorporate the same before finalization of the grades.
- The Student's Grade Card shall contain the Letter-Grade for each registered course; along with the TGPA at the end of the term, and the CGPA at the completion of the programme.

APPEAL FOR REVIEW OF GRADE

- The entire process of evaluation shall be transparent, and the course instructor shall explain to a student the marks he is awarded in various

components of evaluation.

- In case of any grievance about the grades, the student may appeal for review of grades to the Departmental Academic Appeals Board (DAAB) before the date specified in Academic Calendar.
- The fee for such an appeal will be decided from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student without interest.
- VC shall have power to quash the result of a candidate after it has been declared, if
  (a) he is disqualified for using malpractice in the examination;
  (b) a mistake is found in his result;
  (c) he is found ineligible to appear in the examination

AWARD OF DIVISIONS

- The overall performance of a student will be indicated by two indices:
  (i) **TGPA** which is the Term Grade Point Average
  (ii) **CGPA** which is the Cumulative Grade Point Average

  TGPA for a Term is computed as follows:

  $TGPA = \sum C_i G_i / \sum C_i$

  Where,
  C_i denotes credits assigned to i^{th} course with double-letter grade, and G_i denotes the grade point equivalent to the letter grade obtained by the student in i^{th} course with double-letter grade, including all 'FF' grades in that term.

  CGPA is computed as follows:

  $CGPA = \sum C_i G_i / \sum C_i$

  Where,
  C_i denotes credits assigned to i^{th} course with double-letter grade, and G_i denotes the grade point equivalent to the letter grade obtained by the student in i^{th} course for all courses with double-letter grades, including all 'FF' grades in all terms at the end of the programme.

  For CGPA calculation, the following grades are to be counted:
  (i) Grades in all core courses,
  (ii) The best grades in the remaining eligible courses to fulfill the minimum credits requirement for a programme.
- The degree will be awarded only upon compliance of all the laid down requirements for programme as under:
  (i) There shall be University requirement of earning a minimum credits for a degree, satisfactory completion of mandatory learning courses and other activities as per the course structure.
  (ii) There shall be a minimum earned credit requirement on all Departmental core courses, Elective course and Major Project as specified by BOS.
  (iii) There shall be a maximum duration for complying to the degree requirement.
  (iv) The candidate will be placed in First Division with Honours / First Division with Distinction/First Division/Second Division which will be

mentioned on the degree certificate as under:

DIVISION	CONDITIONS TO BE FULFILLED
First Division with Honours	CGPA $\geq$ 8.5 No 'FF', N or W grade in any course during the programme
First Division with Distinction	CGPA $\geq$ 8.5
First Division	CGPA $\geq$ 6.75
Second Division	CGPA $\geq$ 5.0 but < 6.75

Note: Although, there is no direct conversion from grades to marks, however, for comparison purposes percentage of marks may be assumed to be CGPA multiplied by nine.

M. TECH. DEGREE REQUIREMENTS

- The requirements for the M.Tech. degree programme are as follows:
  (a) **University Requirements:**
    (i) Minimum Earned Credit Requirement for Degree which is 90.
    (ii) Securing a CGPA of at least 5.5.
    (iii) Satisfactory completion of Seminars & Teaching Practice
  (b) **Programme Requirements:**
  Minimum Earned Credit Requirements on all compulsory courses, Core Courses, Elective Courses and dissertation as specified by the BOS and conforming to Course Structure given above.
  (c) The Maximum duration for a student for complying to the degree requirement from the date of registration for his first Term, is FOUR years for full-time registration and FIVE years for part-time registration.

GRADE IMPROVEMENT

- A student may be allowed to improve CGPA in an appropriate term if his CGPA falls below 5.5.

TERMINATION FROM THE PROGRAMME

- A student shall be required to leave the University without the award of the Degree, under the following circumstances:
  (a) If a student fails to earn the minimum credits specified below:

(i) Full-time student

Check Point	Credit Threshold *
End of FIRST year	20

(ii) Part-time student

Check Point	Credit Threshold *
End of FIRST year	15
End of SECOND year	30

* If at any stage, a student fails to cross the threshold with a minimum CGPA of 5.5, he will be treated as a critical case and will be advised to improve the grades.

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.

(b) If a student is absent for more than 4 (Four) weeks in a Term without sanctioned leave.

(c) Based on disciplinary action to that effect approved by the AC, on the recommendation of the appropriate committee.

- Under any circumstances of termination, the conditions specified in Permanent Withdrawal shall also apply.

WITHDRAWAL FROM PROGRAMME

Temporarily:

- A student who has been admitted to a degree programme of the University may be permitted to withdraw temporarily, for a period of one term or more, on the grounds of prolonged illness or grave calamity in the family, etc., provided:
  (i) He applies to the LU stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent / guardian
  (ii) There are no outstanding dues or demands, from the Departments / LU / Hostels / Library and any other centers;
  (iii) Scholarship holders are bound by the appropriate Rules applicable to them.
  (iv) The decision of the VC of the LU regarding withdrawal of a student is final and binding.
- Normally, a student will be permitted only one such temporary withdrawal during his tenure as a student and this withdrawal will not be counted for computing the duration of study.

Permanently:

- Any student who withdraws permanently admission before the closing date of admission for the Academic Session is eligible for the refund of fee as per the University rules. Once the admission for the year is closed, the following conditions govern withdrawal of admission:
- A student who wants to leave the LU for good, will be permitted to do so (and take Transfer Certificate from the LU, if needed), only after clearing all the dues for the remaining duration of the course.
- A student who has received any scholarship, stipend or other form of assistance from the LU shall repay all such amounts, in addition, to those mentioned in clause No. G8.2 (a) above.
- The decision of the VC regarding all aspects of withdrawal of a student shall be final and binding.

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Scheme of Studies
&
Syllabus

M. Tech. (Full Time/Part Time)
Electronics & Communication Engineering

M.Tech.
Electronics & Communication Engineering

OBJECTIVES

After going through the study programme the students will be proficient to perform hardware design and take up R&D work in the general fields of signal processing, VLSI and wireless network design.

Furthermore, they will be in a position to use advanced software tools such as LABVIEW, MATLAB, QUALNET, VHDL, Pspice and various Embedded Application Tools for solving real life problems and Hardware development work.

Lastly, they can look for a career in the areas of Advance Signal Processing, Wireless and Mobile Communication Engineering. Additionally, they are given an opportunity to teach under graduate students which may lead them to opt for a teaching career.

Scheme of Studies
M.Tech. (Full Time)

1st Year

TERM – I				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	MA-501	Numerical Techniques	5-1*-0	4
2	EC-501	Signal Theory	5-1*-0	4
3	EC-502	Digital Signal Processing	5-1*-0	4
4	EC-553	Simulation Lab	0-0-4	2
5	EC-552	Digital Signal Processing Lab	0-0-4	2
15-3-8(26)				**16**

TERM – II				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-504	Digital Communication & Information Theory	5-1*-0	4
2	EC-505	Microprocessor and its Applications	5-1*-0	4
3	EC-506	Advanced Digital Signal Processing	5-1*-0	4
4		Elective - I	5-0-0	3
5	EC-555	Microprocessor Lab	0-0-4	2
20-3-4(27)				**17**

TERM – III				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-510	Digital System Design	5-1*-0	4
2	EC-511	Embedded Systems and Applications	5-1*-0	4
3		Elective - II	5-0-0	3
4	EC-565	Seminar-I	0-0-2	1
5	EC-560	Digital System Design Lab	0-0-4	2
15-2-6 (23)				**14**

2nd Year

TERM – IV				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-601	General and Special Purpose Digital Signal Processing	5-1*-0	4
2	EC-602	Analog MOS Integrated Circuit for Signal Processing	5-1*-0	4
3	EC-651	DSP Processors and Application Lab	0-0-4	2
4	EC-653	Dissertation Preliminary **	0-0-10	(5)
5	EC-654	Seminar-II	0-0-4	2
10-2-18 (30)				**12**

TERM – V				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-605	Statistical Signal Processing	5-1*-0	4
2	EC-656	Dissertation Phase-I **	0-0-12	(6)
3	EC-657	Minor Project	0-0-6	3
4	EC-658	Seminar-III	0-0-4	2
5-1-22 (28)				**9**

TERM – VI				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-659	Dissertation Phase-II	0-0-24	12+5+6
2	EC-660	Teaching Practice-I***		(2)
3	EC-661	Teaching Practice-II		2+2
0-0-24 (24)				**27**

List of Electives

Elective – I				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-507	Wireless Communication	5-0-0	3
2	EC-508	Artificial Intelligence	5-0-0	3
3	EC-509	Optical Fibre Communication System	5-0-0	3

Elective – II				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-512	Radar System Analysis and Design	5-0-0	3
2	EC-513	Sonar Signal Processing	5-0-0	3
3	EC-514	Digital Image Processing	5-0-0	3

(L-T-P-Cr) - Lectures-Tutorials-Practicals-Credits

FINAL EVALUATION IN GRADES

* Period will be used for self study resulting in submission of Term Paper.

** Credits earned (5/6) through evaluation will be added in Term-VI under the course Dissertation Phase-II.

*** Credits earned (2) through evaluation will be added under course EC-661 Teaching Practice-II. It is a mandatory learning course.

Scheme of Studies
M.Tech. (Part Time)

1st Year

TERM – I				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	MA-501	Numerical Techniques	5-1*-0	4
2	EC-501	Signal Theory	5-1*-0	4
3	EC-553	Simulation Lab	0-0-4	2
10-2-4 (16)				**10**

TERM – II				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-502	Digital Signal Processing	5-1*-0	4
2	EC-504	Digital Communication & Information Theory	5-1*-0	4
3	EC-552	Digital Signal Processing Lab	0-0-4	2
10-2-4 (16)				**10**

TERM – III				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-505	Microprocessor and its Applications	5-1*-0	4
2	EC-506	Advanced Digital Signal Processing	5-1*-0	4
3	EC-555	Microprocessor Lab	0-0-4	2
10-2-4 (16)				**10**

2nd Year

TERM – IV				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-510	Digital System Design	5-1*-0	4
2		Elective – I	5-0-0	3
3	EC-560	Digital System Design Lab	0-0-4	2
10-1-4 (15)				**9**

TERM – V				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-601	General and Special Purpose Digital Signal Processing	5-1*-0	4
2		Elective –II	5-0-0	3
3	EC-651	DSP Processors and Application Lab	0-0-4	2
10-1-4 (15)				**9**

TERM – VI				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-511	Embedded Systems and Applications	5-1*-0	4
2	EC-657	Minor Project	0-0-6	3
3	EC-565	Seminar – I	0-0-2	1
5-1-8 (14)				**8**

3rd Year

TERM – VII				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-602	Analog MOS Integrated Circuit for Signal Processing	5-1*-0	4
2	EC-653	Dissertation Preliminary**	0-0-10	(5)
3	EC-654	Seminar – II	0-0-4	2
5-1-14 (20)				**6**

TERM – VIII				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-605	Statistical Signal Processing	5-1*-0	4
2	EC-656	Dissertation Phase - I**	0-0-12	(6)
3	EC-658	Seminar – III	0-0-4	2
5-1-16 (22)				**6**

TERM – IX				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-659	Dissertation Phase – II	0-0-24	12+5+6
2	EC-660	Teaching Practice***		(2)
3	EC-660	Teaching Practice		2+2
0-0-24 (24)				**27**

List of Electives

Elective – I				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-507	Wireless Communication	5-0-0	3
2	EC-508	Artificial Intelligence	5-0-0	3
3	EC-509	Optical Fibre Communication System	5-0-0	3

Elective – II				
S.N.	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	EC-512	Radar System Analysis and Design	5-0-0	3
2	EC-513	Sonar Signal Processing	5-0-0	3
3	EC-514	Digital Image Processing	5-0-0	3

(L-T-P-Cr) - Lectures-Tutorials-Practicals-Credits

FINAL EVALUATION IN GRADES

* Period will be used for self study resulting in submission of Term Paper.

** Credits earned (5/6) through evaluation will be added in Term-IX under course Dissertation Phase-II.

*** Credits earned (2) through evaluation will be added under course EC-661 Teaching Practice-II. It is a mandatory learning course.

EC-501	SIGNAL THEORY	L T P	Cr
		5 1 0	4

1 **PROBABILITY AXIOMS:** Conditional probability; Baye's theorem; random variable concept; discrete and continuous random variables; cumulative distribution function (CDF); probability density function (PDF); conditional PDF; expected value; variance; functions of random variable; expected value of the derived random variable.
2 **MULTIPLE RANDOM VARIABLES:** Joint CDF / PDF; Functions of multiple random variable; multiple function of multiple random variables independent / uncorrelated random variables; sums of random variable; moment generating function; random sums of random variable; central limit theorem
3 **RANDOM PROCESS**: Introduction to random process; specification of random processes; nth order joint PDF; stationary and independence; Markov process; Markov property; Gaussian process; Poisson process; Mean and correlation of random processes; stationary; wide sense stationary; ergodic processes; mean square continuity; mean square derivatives.
4 **POWER SPECTRUM**: Random processes as input to linear time invariant systems; power density spectrum; cross-power density spectrum and their properties; relationship between power Spectrum and autocorrelation function; relationship between cross-power spectrum and cross-correlation function; Gaussian process as inputs to LTI system.
5 **NOISE:** Shot noise; thermal noise; white noise; ideal low pass filtered white noise; colored noise; noise equivalent bandwidth; narrow band noise and properties.
6 **MODELING OF NOISE SOURCE:** resistive (Thermal) noise source; effective noise temperature; incremental modeling of noisy network, available power gain; effective input noise temperature; spot noise figures.
7. **ESTIMATION THEORY**: Bayes estimation: mean square error criterion, absolute value criterion, uniform cost function criterion; Cramer's – Rao inequality for non-random and random parameters.

REFERENCE BOOKS

1. Papoulis, A. and Pillai, S. U., "Probability, Random Variable and Stochastic Process", 4th Edition, McGraw Hill, 2002,
2. Krishnan, V., "Probability and Random Processes", John wiley & Sons.
3. Payton, Z. and Peebles, JR, "Probability, Random Variables and Random Signal Principles", 4th edition, McGraw Hill, 2000
4. Stark, H. and Woods, J.W., "Probability and Random Processes with Application to Signal Processing", Prentice Hall, 2002.

EC-502	DIGITAL SIGNAL PROCESSING	L T P	Cr
		5 1 0	4

1 **DISCRETE TIME SIGNALS AND SYSTEMS:** Introduction; discrete-time signals - sequences i.e. basic sequences and operations; discrete time systems; memory-less systems; linear time invariant systems; causality;

stability properties of linear time-invariant systems; frequency-domain representation of discrete-time signals and systems; Representation of sequences by Fourier transforms; symmetry properties and theorems of Fourier transform; discrete-time random signals.
2 **Z-TRANSFORMS:** Introduction; properties of Z-transform; region of convergence; inverse Z-transform-partial fraction expansion; power series expansion; application of Z-transform; system function; poles and zeros.
3 **STRUCTURES OF DIGITAL FILTERS:** Basic structures of infinite impulse response (IIR) and finite impulse response (FIR); filters – direct form; cascade form; parallel form; feedback in IIR system; transposed forms design of FIR and IIR filters using all standard procedures.
4 **FREQUENCY TRANSFORMATIONS**: Frequency transformations in the analog and digital domain. Discrete Fourier Transform (DFT)- properties of DFT; linear convolution using DFT; computation of DFT using fast Fourier transform (FFT)
5 **ERRORS IN DIGITAL FILTERING:** Errors resulting from rounding and truncation; round-off effects in digital filters; finite word length effects in digital filter.
6 **MULTIRATE DIGITAL SIGNAL PROCESSING (MDSP):** Sampling rate conversion; multistage implementation of sampling rate conversion; application of multi rate DSP for design of phase shifters; narrow band low pass filters; quadrature mirror filters, digital filter banks.
7 **HARDWARE IMPLEMENTATION OF DSP:** Introduction to DSP processor; architecture of DSP processors; DSP devices : Von Neumann model, Harvard architecture.

REFERENCE BOOKS

1. Alan, V. Oppenheim and Ronald, W. Schafer, "Digital Signal Processing", Prentice Hall of India, 1998
2. Mitra, Sanjit K., "Digital Signal Processing", Tata McGraw Hill, 2002
3. Proakis, "Digital Signal Processing", Prentice Hall of India, 2002

EC-504	DIGITAL COMMUNICATION & INFORMATION THEORY	L T P	Cr
		5 1 0	4

1 **SIGNALS & CLASSIFICATION:** Fourier series and Fourier transform autocorrelation and cross correlation; cross correlation of energy and power signal; Rayleigh energy theorem; probability theory; Gaussian process.
2 **NOISE:** Sources of noise; signal to noise ratio; noise figure; noise temperature; sampling theorem.
3 **WAVEFORM CODING TECHNIQUES:** Quantization; pulse code modulation (PCM); PCM generator and receiver; Compounding in PCM; delta modulation; adaptive delta modulation; differential PCM; comparison of digital pulse modulation method.
4 **DIGITAL MODULATION TECHNIQUES:** Introduction; ASK, PSK, FSK, MSK, QPSK, BPSK; detection of binary modulation techniques in the presence of noise; error probability in ASK, PSK, FSK; spread spectrum.

5 **INFORMATION THEORY:** Concept of information and entropy; Shannon theorem; channel capacity self information; discrete and continuous entropy; mutual and joint information; redundancy.

6 **CODING THEORY:** Source encoding & channel encoding; error detection and correction; various codes for channel coding; rate distortion functions.

7 **ERROR CONTROL CODE:** Introduction to block coding and optimal decoding; binary hamming code; structure of linear code; decoding of linear block code; reed muler code; structure of cyclic code; Bose Chaudhary Hocquenghem (BCH) codes; cyclic hamming code.

REFERENCE BOOKS

1. Proakis, J.G., "Digital Communication", 3rd edition, Tata McGraw Hill, 1990.
2. Sklar, Bernard, "Digital Communications: Fundamentals and Applications", Prentice Hall of India, 2003.
3. Hawkins, Simon and Wiley, John, "Communication System", 3rd edition, 2004.
4. Wilson, S.G., "Digital Modulation and Coding", Prentice Hall of India, 1996.

EC-505	MICROPROCESSORS AND ITS APPLICATIONS	L T P	Cr
		5 1 0	4

1 **MICROCOMPUTER HARDWARE:** Microprocessor; architecture; system bus; memory organization; I/O; addressing modes; instruction types.

2 **INTERRUPTS:** Timing and machine cycles; peripheral interfacing – DMA controller; CRT controller-8275; floppy disk interface and floppy disk controller-8272.

3 **PROCESS CONTROL COMPUTER SYSTEMS**: Process control languages; types of computers – main frames; minicomputers; microcomputers; performance evaluation techniques.

4 **MICROPROCESSOR AND MICROCOMPUTER SELECTION** : Matching processors and applications; defining the application; software requirements; memory requirements; interfaces; coprocessor; future needs and expandability; power requirements; maintenance; cost effective design.

5 **DEVELOPMENT TOOLS:** Development systems for micros; software tools; logic analyzer; cross assemblers; compilers; and simulators.

6 **DATA COMMUNICATION:** Information coding; asynchronous and synchronous data communication; data communication standards : RS232C and RS485; USART; IEEE-488 GPIB

7 **APPLICATIONS:** Stepper motor interface; temperature controller with an analog and digital computer using a temperature sensor; microprocessor based speed-monitoring unit of DC motor; frequency measurement.

REFERENCE BOOKS

1. Rafiquzzaman, "Microprocessor - Microprocessors and Microcomputer-Based System Design", CRC Press, 1990.

2. Slater, "Microprocessor based Design: A Comprehensive Guide to Effective Hardware Design", Prentice Hall of India, 2002.
3. Mathur, A.P., "Introduction to Microprocessors", Tata McGraw Hill, 1997.
4. Bray "Intel Microprocessor 8086/8088: Architecture, Programming and Interfacing", Prentice Hall of India.
5. Ghoshal, S. "Microprocessor Based System Design", Macmilan, 2000.

EC-506	ADVANCED DIGITAL SIGNAL PROCESSING	L T P	Cr
		5 1 0	4

1 **PARAMETRIC METHODS FOR POWER SPECTRUM ESTIMATION:** Relationship between the auto correlation and the model parameters; the Yule-Walker method for the AR Model Parameters; the Burg method for the AR model parameters; unconstrained least-squares method for the AR Model parameters; sequential estimation methods for the AR Model parameters; selection of AR model order.

2. **FOURIER TRANSFORM**: Multi-dimensional Fourier transform; Fourier transform: power and limitations; short time Fourier transform; Gabor transform : discrete time Fourier transform and filter banks.

3 **ADAPTIVE SIGNAL PROCESSING:** FIR adaptive filters; steepest descent adaptive filter; LMS algorithm; convergence of LMS algorithms; application: noise cancellation; channel equalization; adaptive recursive filters; recursive least squares.

4 **MULTIRATE SIGNAL PROCESSING**: Decimation by a factor D; interpolation by a factor I; filter design and implementation for sampling rate conversion: Direct form FIR filter structures; polyphase filter structure.

5 **WIENER FILTERING:** Introduction, The principal of orthogonality; IIR Wiener filters; FIR Wiener filters Wiener Prediction; the Levinson; Durbin algorithm; Lattice Wiener filtering; lattice predictor properties.

6 **WAVELET TRANSFORMS:** Continuous wavelet transform; wavelet transform ideal case; perfect reconstruction filter banks and wavelets; recursive multi-resolution decomposition; Haar wavelet; Daubechies wavelet.

7. **HOMOMORPHIC SIGNAL PROCESSING:** Introduction; homomorphic system for convolution; properties of complex spectrum.

REFERENCE BOOKS

1. John, G. Proakis, Dimitris, G. Manobakis, "Digital Signal Processing, Principles, Algorithms and Applications", Third edition, Prentice Hall of India, 2000.
2. Monson, H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley, 2002.
3. Glenn, Zelniker, Fred, J. Taylor "Advanced Digital Signal Processing", CRC Press-Publication, 2004.
4. Rabiner, L.R. and Schaber, R.W., "Digital Processing of Speech Signals", Pearson Education, 1979.

5. Roberto Crist, "Modern Digital Signal Processing", Thomson Brooks/Cole, 2004
6. Raghuveer, M. Rao, Ajit, S. Bopardikar, "Wavelet Transforms, Introduction to Theory and applications", Pearson Education Asia, 2000.

EC-507	WIRELESS COMMUNICATION	L T P	Cr
		5 0 0	3

1 **INTRODUCTION**: Introduction to wireless communication system; various generation wireless networks; cellular concepts; interface and system capacity; trunking and grade of service improving coverage and capacity in cellular system.
2 **FADING AND MOBILE CHARACTERISTICS REPRESENTATION**: Small scale fading; frequency selective fading; fading effect due to Doppler spread; coherence BW and coherence time; Rayleigh fading distribution; Ricean fading; Nakagami distribution; level crossing.
3 **CODING:** Diversity; coding and equalization.
4 **MODULATION TECHNIQUES:** Modulation technique for mobile radio; pulse shaping techniques; linear modulation techniques; constant envelope modulation; spread spectrum modulation techniques; rake receiver.
5 **MULTIPLE ACCESS TECHNIQUES**: Multiple Access Technique for wireless communication; FDMA, TDMA, CDMA, spectral effect of multiple access Schemes.
6 **GSM SERVICES AND FEATURES**: Architecture; frame structure; GSM channel; signal processing in GSM
7 **DESIGN PARAMETERS OF MOBILE UNIT**: Design Parameter at base and mobile unit; Antenna configurations; Noise, power and field stren.

REFERENCE BOOKS

1. Rappaport T.S, "Wireless Communications", Prentice Hall, 1996.
2. William C.Y. Lee, "Mobile Communications Design Fundamentals", 2nd Edition, John Wiley, February 1993.
3. Gordon L. Stuber, "Principles of Mobile Communication", Kluwer Academic, 2nd Edition, 2001.
4. W. Stallings, "Wireless Command Network", Prentice Hall of India, 2003.
5. Schiller, J.,"Mobile Communication", Addison Wesley, 2002.
6. Goodman, D.J., "Wireless Personal Communication Systems", Addison Wesley 1997.

EC-508	ARTIFICIAL INTELLIGENCE	L T P	Cr
		5 0 0	3

1 **PREDICATE CALCULUS IN AI**: Introduction; the Propositional calculus; the predicate calculus; expressions using interference rules; knowledge representation through predicate calculus.
2 **STRUCTURES AND STRATEGIES FOR STATE SPACE SEARCH**: Introduction; graph theory; strategies for state space search; heuristic

search; algorithms for heuristic search; admissibility; monotonicity and informedness; game playing (minimax) using heuristic; back tracking strategies; graph search strategies; heuristic graph search; control strategies of state space search; recursion-based search; pattern-directed search production systems.
3 **KNOWLEDGE REPRESENTATION**: Issues in knowledge representation; a brief illustration of AI representational systems; knowledge representation using predicate logic; semantics net; concept of frames; meta knowledge.
4 **RULE BASED SYSTEMS**: A forward deduction system; backward deduction system; combination of forward and backward system; control knowledge for rule based deduction systems.
5 **ARTIFICIAL NEURAL NETWORKS**: Introduction; different learning laws and architectures; learning through error back propagation; radial basis function; neural computing model: Hopfield net, Boltzman machine.
6 **UNCERTAINTY HANDLING**: Bayesian networks; Dempster-shafer theory; certainty factors; introduction to fuzzy logic.
7 **EXPERT SYSTEMS**: Introduction; architecture of expert system; knowledge acquisition and representation methods in expert systems; few applications of expert systems. Prolog Programming: an introduction and brief overview of the language.

REFERENCE BOOKS

1. Luger, George, "Artificial Intelligence: Structure and Strategies for complex problem solving", Pearson Education, 2004.
2. Bratko, Iven, "Prolog: Programming for artificial intelligence" Person Education., Addison Wesley, 2000.
3. Nilsson, Nils J., "Artificial Intelligence: A New synthesis, Harcart Asia Pvt. Ltd., 1998.
4. Kataipoulos, S.V., "Artificial Intelligence"
5. Yazani, Masound, "Artificial Intelligence", Intellect, 1986.
6. Jack., M. Zwadu, "Introduction to ANN"

EC-509	OPTICAL FIBRE COMMUNICATION SYSTEM	L T P	Cr
		5-0-0	3

1 **OVERVIEW**: Overview of Optical Communication Systems.
2 **REVIEW OF OPTICS**: Wave theory of light; reflection/refraction of plane waves; Fresnel's formulas; interface; diffraction; optical coherence; polarization of light.
3 **PROPAGATION OF LIGHT IN FIBERS**: Concepts of multi modes and single mode fibers; dispersion and attenuation in fibers; comparison of different types of fibers and optical choice of fibers.
4 **OPTICAL WAVE GUIDE**: Planar Conducting waveguides; planar dielectric wave guides; optical fiber wave guides.
5 **OPTICAL SOURCES AND TRANSMITTERS**: LED, semiconductor lasers and their characteristics.

6 **OPTICAL DETECTORS AND RECEIVERS**: Photo detectors and their characteristics; receiver design; noise and sensitivity issues.

7 **SYSTEM DESIGN**: Selection of detectors based on speed; sensitivity and signal to noise ratio; determination of crucial parameters for basic optical devices; translate design requirement into system parameters; optical link design; power and noise budget; jitter / rise time budget.

REFERENCE BOOKS

1. Aggarwal, Govind P., "Fiber Optic Communication System", 3rd Edition, John Wiley Publication, 1989.
2. Palais, Joseph C., "Fiber Optic Communication", 4th Edition, Prentice Hall of India, 2005.
3. Ramaswami, R. and Swarajan, K.N., "Optical Networks: a Practical Perspective", Morgan Kaufmann Publishers, 1998.
4. Gowar, J, "Optical Fiber Communication System", Prentice Hall of India, 1995
5. Keiser, G., "Optical fiber communication", Tata McGraw Hill, 2000.
6. Senior, J.M., "Optical fiber Communication Principles and Practice", Prentice Hall of India, 1992

EC-510	DIGITAL SYSTEM DESIGN	L T P	Cr
		5 1 0	4

1 **INTRODUCTION TO COMPUTER ADDED DESIGN**: Hardware description language (HDL), VHSIC hardware description language (VHDL), data objects, data types, operators.

2 **INTRODUCTION TO MODELING:** Entity declaration; architecture body; behavioral flow of modeling; assignment sequential case array etc.; structural modeling and data flow modeling.

3 **COMBINATIONAL AND SEQUENTIAL CIRCUITS**: VHDL models of combinational and sequential circuits; memory implementation of Boolean function; code converter; ALU.

4 **HARDWARE AND SOFTWARE OF DESIGN UNIT**: Hardware and software firmware consideration in designing control units for arithmetic logical processors; I/O processor with different methods of the data handling, electronics switching; process interface design.

5 **PROGRAMMABLE LOGIC DEVICES**: Programmable logic arrays (PLA) and designing with PLA, PAL, FPGA, CPLD.

6 **APPROACHES TO SEQUENCIAL ANALYSIS AND DESIGN**: State diagram; analysis of sequential synchronous circuits; design steps for sequential synchronous circuits; state reduction; design of output decoders; counters; shift registers and memory.

7 **ASYNCHRONOUS FINITE STATE MACHINES:** Scope; asynchronous analysis; design of asynchronous machines; cycles and races; plotting and Reading the excitation map; essential hazards map entered variable (MEV), MEV approaches to asynchronous design.

REFERENCE BOOKS

1. Fletcher, "Engineering Approach to Digital Design", Prentice Hall of India, 1993.
2. Bhasker, "A VHDL Primer, Pearson Education", Prentice Hall PTR, 2006.
3. Mano, "Digital logic and Computer Design", Prentice Hall of India, 1994
4. Wakerly, "Digital Design: Principles and Practices", Pearson Education, 2005.
5. Smith, D., "HDL Chip Design", Doon Publications 1996.

EC-511	EMBEDDED SYSTEMS AND APPLICATIONS	L T P	Cr
		5 1 0	4

1 **INTRODUCTION TO EMBEDDED SYSTEM :** categories of embedded systems; hardware architecture; CPU; processor architecture interrupts; CISC & RISC; memory; I/O devices; DMA, ADC & DAC; serial peripheral integrate; inter – integrated circuits bus-TCP/IP protocol.

2 **SOFTWARE ARCHITECTURE:** services provided by an operating system; architecture of embedded operating system; categories of embedded operating system.

3 **PROCESS OF EMBEDDED SYSTEM DEVELOPMENT :** waterfall model; requirements engineering; design tradeoffs; co-design; hardware design; software design; implementation; integration & testing; configuration management; managing embedded-system development projects.

4 **COMMUNICATION INTERFACES:** RS-232/UART; RS-422/485; IEEE 1394; USB; Ethernet; wireless interfaces; IEEE 802.11; Bluetooth.

5 **REPRESENTATIVE EMBEDDED SYSTEMS:** digital thermometer; handheld computer; GPS navigation system; internet phone; software : defined Radio; smart cards; RF tags.

6 **EMBEDDED OPERATING SYSTEM**: features of O/S; POSIX; difference in various O/S, embedded NT; Windows XP embedded and embedded Linux.

7. **MICROCONTROLLER ARCHITECTURE:** Introduction to PIC microcontrollers, Architecture and pipelining, program memory considerations, Addressing modes, CPU registers, Instruction set; simple operations.

REFERENCE BOOKS

1. Prasad, K.V.K.K., "Embedded System", Dreamtech Press, 2005.
2. Kamal, Raj, "Embedded System and Applications", TMS, 2002

EC-512	RADAR SYSTEM ANALYSIS & DESIGN	L T P	Cr
		5 0 0	3

1 **RADAR FUNDAMENTALS**: Radar classifications; range; range resolution; Doppler frequency coherence; radar equation; low pulse repetition frequency (PRF) radar equation; high PRF radar equation; surveillance radar equation; radar losses, noise figure.

2 **CONTINUOUS WAVE (CW) AND PULSED RADARS:** Functional block diagram; CW radar equation; frequency modulation (FM); linear FM CW radar pulsed radar; range and Doppler ambiguities; resolving range ambiguities; resolving Doppler ambiguities.

3 **RADAR DETECTION :** Detection in presence of noise; probability of fake alarm; probability of detection; pulse integration; detection of fluctuating targets; probability of detection calculation.

4 **RADAR WAVE PROPAGATION:** Earth atmosphere; refraction; four-third earth model; ground reflection; pattern propagation factor; diffraction; and atmosphere attenuation.

5 **CLUTTER AND MOVING TARGET INDICATOR:** Clutter definition; surface clutter; volume clutter; clutter spectrum; moving target indicator-single delay line canceller; double delay line canceller.

6 **RADAR ANTENNAS**: Directivity, Power gain; effective aperture; near and far fields; general arrays; linear arrays; planer arrays; array scan loss; conventional beam forming.

7 **RADAR CROSS SECTION (RCS):** RCS definition; dependency on aspect angle and frequency RCS dependence on polarization; RCS of simple objects; simplistic approach to calculating the RCS of complex objects.

REFERENCE BOOKS

1. Mahafza, Bassem R., "Radar System Analysis and Design Using MATLAB", Chapman & Hall /CRC Press, 2005
2. Skolnik, Merrill I., "Introduction to Radar Systems", Tata McGraw-Hill, 2001
3. Eddie, Byron, "Radar Principles, Technology, Applications", Pearson Education, 1995

EC-513	SONAR SIGNAL PROCESSING	L T P	Cr
		5 0 0	3

1 **OVERVIEW** : Overview of sonar systems

2 **SONAR BASICS**: Propagation of sound in the ocean; noise in the ocean.

3 **ANALYSIS OF SONAR SIGNALS:** The sonar equation; signal/noise considerations; generation of underwater sound; nonlinear effect of dept.

4 **DETECTION OF SONAR SIGNALS:** Threshold concept; various types of detector; typical problems in detection of sonar signals; adaptive digital filters; digital Doppler nullification.

5 **SONAR ARRAY PROCESSING:** Conventional beamforming; Adaptive beamforming; Beam Steering.

6 **ACTIVE AND PASSIVE SONAR SIGNAL PROCESSING:** Review of signal characteristics; ambient noise and platform noise; waveform selection and ambiguity functions.

7 **SONAR SYSTEMS DESIGN IMPLEMENTAION:** Passive sonar design consideration; active sonar design consideration.

REFERENCE BOOKS

1. Chevalier, Fracois Le, "Principles of Radar and Sonar Signal Processing", ARTECH House, 2002.
2. Urick, R. "Principles of Under Water Sound", McGraw Hill, 1983
3. Waite, A.D., "Sonar for Practicing Engineers", 2002.

EC-514	DIGITAL IMAGE PROCESSING	L T P	Cr
		5 0 0	3

1 **INTRODUCTION**: Elements of digital image processing systems; image acquisition; storage; processing communication display.

2 **DIGITAL IMAGE FUNDAMENTALS**: Visual perception, simple image models; concept of uniform and non-uniform sampling and quantization; relationships between pixels-neighbors of pixel; connectivity labeling of connected components; relations; equivalence and transitive closure; distance measures; arithmetic/logic operation; imaging geometry basic and perspective transformation stereo imaging.

3 **IMAGE TRANSFORMS:** Discrete Fourier transform; 2-D Fourier transforms and its properties; fast Fourier transform and its uses; walsh; hadamard discrete cosine; heir and slant transforms hostelling their algorithms and computer implementations.

4 **IMAGE ENHANCEMENT:** Spatial and frequency domain methods point processing; intensity transformation; histogram processing image substation and averaging spatial filtering; LP, HP and homo-morphic felling; generation of spatial marks; colour image processing.

5 **IMAGE RESTORATION:** Degradation model; digitalization of circulate and block circulate metrics; algebraic approved invoice filtering; wiener filter; constrained least square restoration; interactive restoration in spatial domain geometric transformation.

6 **IMAGE COMPRESSION AND SEGMENTATION:** Redundancy models; error free compression; Lossy compression; image compression standards; segmentation: detection of discontinuity; edge detection; boundary detection; thresholding; regional oriented segmentation use of motion in segmentation.

7 **REPRESENTATION AND DESCRIPTION**: Image analysis; pattern and their classes; decision theoretical methods; structural methods; interpretation.

REFERENCE BOOKS

1. Jain, Anil K, "Fundamentals of Digital Image Processing", Prentice Hall of India, Edition 1997.
2. Gonzalez, Refael C., Woods, Richard E. and Eddins, Steven L., "Digital Image Processing using MATLAB", Pearson Education, 2004.
3. Castleman, Keenneth R, "Digital Image Processing", Pearson Education, 1995.
4. Gonzalez, Refael C. and Woods, Richard E., "Digital Image Processing", Pearson Education, 2002.

EC-552	DIGITAL SIGNAL PROCESSING LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS USING MATLAB

1. Write a Program for generation of unit impulse, unit step, ramp, exponential, sinusoidal and cosine sequence.
2. Write a Program for computing inverse Z-transform of a rational transfer function.
3. Write a Program for linear convolution
4. Write a Program for plotting the frequency response of first order system.
5. Write a Program for computing Discrete Fourier Transform (DFT).
6. Design a Butterworth Low pass IIR filter using Bilinear Z-transform method.
7. Design FIR Low pass filter and High pass filter using Rectangular window.
8. Transform an analog filter in to a digital filter using Impulse Invariant method.
9. Design a Chebyshev Low pass filter.
10. Design FIR low pass filter using Kaiser Window.
11. Determine the execution time of the FFT function.
12. Demonstrate the effectiveness of high-speed convolution FFT algorithm

Note : Atleast 10 experiments are to be performed from the above list.

EC-553	SIMULATION LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS

1. Simulate & Study the results of design of the Frequency Response of an RC Coupled Amplifier using P-SPICE.
2. Simulate using S-PICE and verify the Operation of a Differentiator Circuit using 741 Op-amp and show that it acts as a High pass filter.
3. Simulate using S-PICE and verify the Operation of a Integrator Circuit using 741 Op-amp and show that it acts as a Low pass filter.
4. Simulate using P-SPICE the application of Op-amp 741 as a Square Wave Generator.
5. Simulate and find how many cycles are present in the output of a Pulsed Amplifier.
6. Simulate the design of Logarithmic Amplifier using Op-amp 741.
7. Simulate and study the characteristics of Common Source FET Amplifier using P-SPICE.
8. Simulate and study the V-I Characteristics of MOSFET.
9. Simulate & Implement a given logic Expression using PLA with P-SPICE.
10. Simulate 16:1 Multiplexer and 1:16 Demultiplexer and determine its truth table.
11. Simulate 4-bit Comparator using P-SPICE.
12. Simulate D,S-R,J-K & T Flip flop using NAND gates & study its operation.

13. Simulate using P-SPICE a 3-bit Synchronous Counter & determine its count sequence.
14. Simulate using P-SPICE a 3-bit Shift Register & determine its truth table.

Note : Atleast 10 experiments are to be performed from the above list.

EC-555	MICROPROCESSOR LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS

1. Familiarization with architecture and operation of single board microcomputer.
2. Performing mathematical and logical operations on a single board microcomputer.
3. Familiarization with DEBUG program and its commands to execute and debug

1. Assembly Language Programs (ALP).
4. Write a program for a 16 bit processor to
    a. Find the largest number in a data array.
    b. Find the smallest number in a data array.
5. Write a program for a 16 bit processor to find the sum of a series of 16 bit numbers.
6. Write a program for speed control of DC series motor.
7. Design a microprocessor based temperature monitoring unit.
8. Write a program for a traffic light control with emergency control using Interrupts.
9. Familiarization with architecture and operation of an 8 bit Microcontroller.
10. Write an ALP to generate 10 KHz square wave.
11. Write an ALP to interface Microprocessor and LCD display.
12. Write an ALP to interface one microcontroller with other using serial communication

Note : Atleast 10 experiments are to be performed from the above list.

EC-565	SEMINAR-I	L T P	Cr
		0 0 4	2

The student has to undertake extensive literature survey on a topic with the approval of the course coordinator. The course coordinator shall not be below the rank of Assistant Professor. The work may involve extensive search of print, audio-video materials, internet surfing etc.

The work of monitoring will be done by the course coordinator and evaluation by the course coordinator and the HOD or his nominee.

EC-560	DIGITAL SYSTEM DESIGN LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS

1. Write VHDL code for 3 to 8 priority encoder.
2. Write structural code for 16:1 multiplexer.
3. Write VHDL code of full adder using two half adder.
4. Write VHDL code of BCD to 7 segment code converter using Data Style of modeling.
5. Design a three bit up/down counter using T flip flop.
6. Design a four bit synchronous counter with parallel load using T and D flip flops.
7 Write Behavioral VHDL code for module-12 up counter with synchronous reset.
8. Write VHDL Code for left to right shift registers with enable pin.
9. Create an entity that represents 3 to 8 binary encoder using two instances of 2 to 4 entity.
10. Design four bit comparator using Behavioral and Structural type of modeling.
11. Design an ALU capable of performing arithmetic and logical operations.
12. Design a module-6 counter which counts in the sequence 0,1,2,3,4,5,0,1. The counter counts the clock pulse if its enable pin is equal to 1

Note : Atleast 10 experiments are to be performed from the above list.

EC-601	GENERAL & SPECIAL PURPOSE DIGITAL SIGNAL PROCESSORS	L T P	Cr
		5 1 0	4

1 **INTRODUCTION:** Computer architectures for signal processing; Harvard Architecture; pipelining.

2 **HARDWARE DESIGN:** Hardware multiplier accumulator; special instructions; Replication on chip memory/cache; extended parallelism**:** SIMD, VLIW and static superscalar processing.

3 **GENERAL PURPOSE DIGITAL SIGNAL PROCESSORS** : Fixed point DSP's; Architecture of first generation fixed point DSP processors; Architecture of second generation fixed point DSP's; Architecture of third generation fixed point DSP's; Architecture of fourth generation fixed point processors; floating point digital signal processors.

4 **SELECTING DIGITAL SIGNAL PROCESSORS**: Architectural features; execution speed; type of arithmetic; word length; support for development tools; packaging of a DSP; Clock frequency and MIPS rating.

5 **IMPLEMENTATION OF DSP ALGORITHMS ON GENERAL PURPOSE DSP's**: FIR digital filtering; IIR digital filtering; FFT processing; multirate processing.

6 **SPECIAL PURPOSE DSP HARDWARE**: Basic requirements of special purpose DSP's; hardware digital filters; hardware FFT processors;

architecture of hardware FFT processors; double buffering in real time FFT.

7 **APPLICATIONS OF DSP:** Speech Coding and Decoding; Speech Encryption and Decryption; Speech Recognition.

REFERENCE BOOKS

1. Ifeachor, Emmanuel C., and Jervis, Barrie W., "Digital signal processing – A practical Approach", Second Edition, Pearson Education, 2004.
2. Proakis, John G. and Manolakis, Dimitris, "Digital Signal Processing – Principles, Algorithms and applications", Pearson Education, 2006.
3. Chassaing, R and Horning, D.W., "Digital Signal Processing with the TMS320C2S", Wiley Publications, 1990.
4. Sharkawy, Mohammed EL., "Digital Signal Processor Applications with Motorola's DSP 56002",

EC-602	ANALOG MOS INTEGRATED CIRCUITS FOR SIGNAL PROCESSING	L T P	Cr
		5 1 0	4

1 **OVERVIEW OF MOS TECHNOLOGY**: Analog signal processing; basic MOS semiconductor devices: n-MOS; p-MOS; CMOS inverter.

2 **FABRICATION PROCESS**: Basic fabrication of MOS, n-MOS, p-MOS, CMOS, Bi-MOS, pn-junction; resistor, capacitor.

3 **USE OF DEVICE MODELS IN CIRCUIT ANALYSIS**: MOS models, Bipolar models; monolithic resistors and capacitors.

4 **ANALOG CMOS SUB CIRCUIT:** MOS switch, CMOS current source, current mirrors – Wilson; cascade.

5 **DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERSION**: medium speed, high speed.

6 **SWITCHED CAPACITOR CIRCUIT:** Switch capacitor amplifier; switched capacitor Integrator; Z domain or first order and second order switched capacitor circuit.

7 **NON-FILTERING APPLICATIONS OF SWITCHED CAPACITOR CIRCUITS:** Gain stage; programmable: capacitor arrays; switched: capacitor rectifiers; detectors; oscillators; application in field of signal processing.

REFERENCE BOOKS

1. Allen, "CMOS Analog Circuit Design", Oxford University Press, 2002.
2. Schaumann, "Design of Analog Filters", Oxford University Press, 2001
3. Warner and Grung, "MOSFET Theory and Design", Oxford University Press, 1999.
4 Gregorian and Temes, "Analog MOS integrated Circuits for Signal Processing", John Wiley, 1986.

EC-605	STATISTICAL SIGNAL PROCESSING	L T P	Cr
		5 1* 0	4

1 **INTRODUCTION TO DIGITAL FILTER DESIGN**: FIR filter and IIR filter.
2 **DIGITAL FILTER DESIGN USING LEAST-SQUARE METHOD**: Least square error criterion in the design of Pole-zero filters; FIR least squares inverse filters.
3 **SPECTRAL ESTIMATION AND ANALYSIS**: Non parametric methods: Periodogram; Bartlett and Welch modified period gram; Blackman-Turkey Methods.
4 **SPECTRAL ESTIMATION AND ANALYSIS**: Parametric methods: wide sense stationary random process; rational power spectra: auto regressive (AR) process; moving average (MA) process; ARMA process; relationship between the filter parameters and the auto correlation sequence.
5 **FORWARD AND BACKWARD LINEAR PREDICTION:** Forward linear prediction; backward linear prediction; relationship of an AR process to linear prediction: Yule–Walker method, Levinson–Durbin algorithm.
6 **WIENER FILTERS FOR FILTERING AND PREDICTION:** FIR wiener filter; orthogonality principle in the linear mean-square error (MSE) estimation, IIR wiener filter.
7 **ADAPTIVE ALGORITHMS TO ADJUST COEFFICIENTS OF DIGITAL FILTERS:** Least mean square (LMS); recursive least square (RLS) and Kalman filter algorithms.

REFERENCE BOOKS

1. Proakis, John G., Dimitris G. Manolakis, and D. Sharma: Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 2006
2. Ingle, Vinay K. and Proakis, John G., "Digital Signal Processing Using MATLAB", Brooks/Cole/Thomson Learning, 2001.
3. Lfeachor, Emmanuel C., and Jervis, Barrie W. "Digital Signal processing, A Practical Approach", Pearson Education, 2002
4. Mitra, Sanjit. K, "Digital Signal Processing a Computer Based Approach", Tata McGraw Hill, 2001.

EC-651	DSP PROCESSORS AND APPLICATION LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS

1. Familiarization with the architecture and operation of first generation fixed point DSP Texas Instruments TMS320C10.
2. Familiarization with the architecture and operation of second generation fixed point DSP Texas Instruments TMS320C50.
3. Familiarization with the architecture and operation of third generation fixed point DSP Texas Instruments TMS320C54x.
4. Familiarization with the architecture and operation of fourth generation fixed point DSP Texas Instruments TMS320C62x

5. Write an assembly language program for TMS320C10 based FIR digital notch filter.
6. Write an assembly language program for TMS320C10 based FIR digital low pass filter.
7. Write an assembly language program for TMS320C10 based FIR digital high pass filter.
8. Write an assembly language program for TMS320C10 based FIR digital band pass filter.
9. Write an assembly language program for TMS 320C25 based FIR digital notch filter.
10. Write an assembly language program for TMS 320C25 based FIR digital band pass filter.
11. Write an assembly language program for TMS 320C25 based FIR digital low pass filter.
12. Write an assembly language program for TMS 320C25 based FIR digital high pass filter.

Note : Atleast 10 experiments are to be performed from the above list.

EC-653	DISSERTATION PRELIMINARY	L T P	Cr
		0 0 10	5

See note as given under course EC-659.

EC-654	SEMINAR-II	L T P	Cr
		0 0 4	2

The work of Dissertation Preliminary is to be presented by the student in the form of Seminars II.
The work of monitoring will be done by the guide and evaluation by the committee consisting of guide, course coordinator and the HOD or his nominee.

EC-656	DISSERTATION PHASE-I	L T P	Cr
		0 0 12	6

See note as given under course EC-659.

EC-657	MINOR PROJECT	L T P	Cr
		0 0 6	3

The student is required to do the design/fabrication/coding/simulation of equipment/process/system of his/her choice and to be approved by the course coordinator.

The course coordinator will evolve the evaluation procedure under the guidance of HOD.

EC-658	SEMINAR-III	L T P	Cr
		0 0 4	2

The work of Dissertation Phase-I is to be presented by the student in the form of Seminars III.

The work of monitoring will be done by the guide and evaluation by the committee consisting of guide, course coordinator and the HOD or his nominee.

EC-659	DISSERTATION PHASE-II	L T P	Cr
		0 0 24	12

Every student will carry out dissertation under the supervision of a guide. The topic of dissertation shall be approved by a committee constituted by the HOD. The method of evaluation including intermediate assessment shall be as evaluated by the pertinent BOS.

Dissertation work is spread over three terms and coded as EC-653, EC-656 and EC-659. The distribution of amount of work in these three terms is equivalent to 5, 6 and 12 credits respectively. The evaluation of work is continuous but award of grade is for 23 credits in the last term on the basis of total work.

EC-660	TEACHING PRACTICE-I	L T P	Cr
		- - -	2

See note as given under course EC-661.

EC-661	TEACHING PRACTICE-II	L T P	Cr
		- - -	2

Teaching practice comprises of two non-two letter mandatory courses to be done under the guidance of HOD. Here, the student is required to be engaged in teaching of two UG courses (I and II) of his/her choice during the period between IVth to IXth Terms of the M.Tech. Degree Programme. The student shall register for Teaching Practice only at the time he plans to take up teaching of UG course, but the credits earned will be counted in Term-VI for Full Time students and Term-IX for Part Time students.

MA-501	NUMERICAL TECHNIQUES	L T P	Cr
		5 1 0	4

1. **LINEAR EQUATIONS**- Matrix theory; solution of general linear system of equations, existence & uniqueness of solution, Echelon form of matrix; I, II conditioned matrices Eigen value & Eigen vectors; Unitary, Hermittian & normal matrices; Gauss-elimination method and Gauss-Jordan methods for homogeneous and non-homogeneous systems of linear equations; round off errors
2. **NON-LINEAR EQUATIONS**: Bisection method; linear interpolation methods; Newton's method; Muller's method; Bairstow's methods for the quadratic factors; other methods for the solution of polynomials.
3. **INTERPOLATION PROBLEMS**: Lagrangian polynomial; divided differences; interpolating with cubic spline; bexier curves and B-spline curves; polynomial approximation of the surfaces; least square method.
4. **DIFFERENTIATION & INTEGRATION:** Derivatives from difference table; higher order derivatives; extrapolation techniques; integration formulas- Simpson's rule, trapezoidal rule, Gaussian quadrature; adaptive integration, multiple integrals.
5. **SOLUTION OF ORDINARY DIFFERENTIAL EQUATION**: Modifier Euler methods; Milne's methods Adam's Moulton method; convergence criteria, Errors and error propagation, comparison of different methods.
6. **BOUNDARY VALUE PROBLEMS**: Shooting method; Rayliegh-Ritz method; Collocation and Galerkin method; characteristic value problem, eigen values by iteration and QR method; application of Eigen values.
7. **SOLUTION OF PARTIAL DIFFERENTIAL EQUATION:** Laplace's equations on a rectangular region; iterative method for the Laplace equation; Poisson equation; A.D.I method; solution of parabolic differential equation by Crank – Nicholson method; theta method; solution of wave equation by Finite differences; wave equation in two dimensions.

REFERENCE BOOKS:

1. Kreyszg, Erwin, "Advanced Engineering Mathematics", John Wiley,1999.
2. Greenberg, Mchale. D "Advanced Engineering Mathematics" Second Edition, Pearson Education, 1998.
3. Jain, R.K. & Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa 2002.
4. Gerald, Curts F & Wheatley, Patrick O, "Applied Numerical Analysis", 5th Ed., Wesley, 1998.
5. Jain, M.K., Iyengar, S.R.K. & Jain, R.K. "Numerical Methods for scientific & Engineering Computation", New Age, 1993

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