राष्ट्रीय प्रौद्योगिकी संस्थान मणिपुर

NATIONAL INSTITUTE OF TECHNOLOGY MANIPUR

Minutes of the

20th Senate Meeting

Day: Wednesday Date: 24/02/2021

Time: 11.00 AM

MINUTES OF THE 20th SENATE MEETING HELD ON 24th FEBRUARY,2021

The 20th Senate Meeting of National Institute of Technology Manipur was held on 24th February, 2021 at 11.00 AM.

The following members were present:

❖ Prof. (Dr.) Goutam Sutradhar Director, NIT Manipur	:	Ex-officio Chairman
❖ Prof. Memcha Loitongbam Manipur University	:	Member
❖ Prof. Debkumar Chakrabarti IIT Guwahti	:	Member
❖ Prof. Chiranjib Bhattacharjee Jadavpur University	:	Member
❖ Dr. Jisnu Basu Saha Institute of Nuclear Physics, Kolkata	:	Distinguished Invitee
❖ Dr. Prabir Kumar Mukhopadhyay Damodar Valley Corporation	:	Distinguished Invitee
❖ Dr. P. Albino Kumar Dean (AA), NIT Manipur	:	Member
❖ Prof. Rajesh Kumar Bhushan Mechanical Engineering Deptt., NIT Manipur	:	Member
❖ Dr. M. Sunil Singh HoD, Civil, NIT Manipur	:	Member
❖ Dr. Shuma Adhikari HoD, EE, NIT Manipur	:	Member
❖ Dr. Manoj Kumar HoD, ECE, NIT Manipur	:	Member
❖ Dr. Kh. Johnson Singh HoD, CSE, NIT Manipur	:	Member
❖ Dr. H. Neeranjan Singh HoD, Mechanical Engg., NIT Manipur	:	Member
❖ Dr. Ch. Barchand Singh HoD, Mathematics Deptt., NIT Manipur	:	Member
❖ Dr. Bibhu Prasad Swain HoD, Physics Deptt., NIT Manipur	:	Member
❖ Dr. Chandi Charan Malakar HoD, Chemistry Deptt., NIT Manipur	:	Member
❖ Dr. Sangeeta Laishram HoD, HSS, NIT Manipur	:	Member
❖ Prof. Kh. Manglem Singh Registrar (i/c), NIT Manipur	:	Secretary

At the outset, the Director NIT Manipur welcomed all the new members and the distinguished invitees.

The Director invited the Registrar (i/c) to initiate the proceedings on the agenda items.

ITEM NO. 20.1: **Confirmation of the minutes of the 19th Senate meeting held on 03/11/2020 via Video Conferencing**

The Senate confirmed the minutes of the 19th Senate meeting held on 03/11/2020.

ITEM NO. 20.2: **Action taken on the decision of the 19th Senate Meeting held on 03/11/2020 via Video Conferencing**

The actions taken on various decisions of the 19th meeting of the Senate are as follows:

Sl. No.	Item No.	Agenda	Decision Taken	Action Taken	Remarks
1.	ITEM NO. 19.3:	To consider and approve the Academic Calendar (November 2020- March 2021) for B.Tech. 1st year admitted in 2020-21 Academic Session	The Senate approved the Academic Calendar (November 2020- March 2021) for B.Tech. 1st year admitted in 2020-21 Academic Session (Online Classes due to COVID-19)	Complied	Noted
2.	ITEM NO. 19.4	To ratify the award of B.Tech. degree to students who passed out in 2020	The Senate ratified the award of B.Tech. Degree to 109 students who were awarded degree by the 7th Convocation held on 12/10/2020	Noted	Noted
3.	ITEM NO. 19.5	To ratify the award of M. Tech degree to students who passed out in 2020	The Senate ratified the award of M.Tech Degree to 57 students who were awarded degree by the 7th Convocation held on 12/10/2020	Noted	Noted
4.	ITEM NO. 19.6	To ratify the award of M. Sc degree to students who passed out in 2020	The Senate ratified the award of M.Sc Degree to 30 students who were awarded degree by the 7th Convocation held on 12/10/2020	Noted	Noted
5.	ITEM NO. 19.7	To ratify the award of Ph.D degree	The Senate ratified the award of Ph.D Degree to 15 students who were awarded degree by the 7th Convocation held on 12/10/2020	Noted	Noted
6.	ITEM NO. 19.8	To ratify the Award of Gold Medals to B.Tech. toppers who passed in 2020.	The Senate ratified the award of Gold Medals to B. Tech toppers. The Chairman's Gold (Overall Topper) and Institutional Gold medals (Branch toppers) in B.Tech programme were awarded by the 7th Convocation held on 12/10/2020	Noted	Noted
7.	ITEM NO. 19.9	To ratify the promotion of Felix Pougongrhei Gonmei (16104002) of Electrical Engineering Department to 5th Semester in the August – December, 2020 session	The Senate ratified the promotion of Felix Pougongrhei Gonmei (16104002) of Electrical Engineering Department to 5th Semester in the August –December, 2020 session on a case to case basis	Noted	Noted
8.	ITEM NO. 19.10	To ratify the promotion of Khuplianlal (17103033) of Computer Science and Engineering Department to 7th Semester in the August –December, 2020 session	The Senate ratified the promotion of Khuplianlal (17103033) of Computer Science and Engineering Department to 7th Semester in the August –December, 2020 session on a case to case basis	Noted	Noted

9.	ITEM NO. 19.11	Miscellaneous: Prof. Rajesh Kumar Bhushan proposed three new courses in Mechanical Engineering for Ph.D course work for approval viz. 1. Code: ME563 Advanced Mechanics of Solids 3-0-0-6 2. Code: ME565 Mechanics of Composite Materials 3-0-0-6 3. Code: ME580 Advanced Mechatronics 3-0-0-6	The Senate approved the Syllabi of the above three electives in Mechanical Engineering Department both for M.Tech and Ph.D programme.	Noted	Noted

ITEM NO. 20.3: **To consider to provide scholarship to new M.Tech/ PhD students from the day of first class**

The 20th Senate approved to provide scholarship/fellowship to new M.Tech/ PhD students from the day of their first class for those students with GATE/NET qualification.

ITEM NO. 20.4: **To ratify the Enrolment coding of different programmes/ departments / discipline**

The 20th Senate meeting ratified the Enrolment coding of different programmes/departments/discipline which is appended at **Annexure-1**.

ITEM NO. 20.5: **To consider to approve in fixing the PhD thesis expert honorarium**

The 20th Senate meeting approved in fixing the Ph.D thesis expert honorarium as

1. Thesis Correction : Rs. 10,000 (Indian)
2. Thesis Correction : $ 500
3. Viva Voce Expert : Rs. 5,000 / $ 250

ITEM NO. 20.6: **To discuss the deduction and cancellation policy of seats of the student**

The 20th Senate meeting recommended to refund to the students who have cancelled their seats after the final admission in 1st year (B.Tech/M.Sc/M.Tech/Ph.D) in NIT Manipur subject to approval of the Finance Committee and BoG meeting which are detailed below. The students have the opportunity to withdraw the admission from NIT Manipur before the last round of central counselling; however, few candidates still reserved the seats and cancelled it after the last round. Blocking such seats deprived the deserving candidates from admission to NIT Manipur

and also created a huge loss of tuition & institutional development fees for the remaining 7 semesters.

B.Tech		M.Tech		M.Sc		PhD	
Items	Amount (Rs.)	Items	Amount (Rs.)	Items	Amount (Rs.)	Items	Amount (Rs.)
Students Activity fee	100	Students Activity fee	1000	Laboratory fee	400	Students Activity fee	100
Medical Insurance & OPD facilities fee (per annum)	1200	Medical Insurance & OPD facilities fee (per annum)	1200			Medical	1000
Caution Money (Refundable)	5000	Caution Money (Refundable)	5000			Caution Money (Refundable)	5000
Grade Card fee	500	Grade Card fee	500	Grade Card fee	500	Grade Card fee	1000
Smart ID fee	200	Smart ID fee	200	Smart ID fee	200	Smart ID fee	200
Prospectus Fee	300			Exam Fee	250	Alumni fee	300
						Degree Certificate fee	500
Total	**8200**		**7900**		**1350**		**9000**

ITEM NO. 20.7: **To permit B.Tech final year students to give their project presentation after the end semester examination for the present academic session**

The 20th Senate meeting approved in permitting B.Tech final year students to give their project presentation after the end semester examination for the present academic session.

ITEM NO. 20.8: **To discuss on yearly contingencies carry over for the PhD student**

The 20th Senate meeting approved that there should not be any contingencies carry over from one financial year to another for the Ph.D students.

ITEM NO. 20.9: **To discuss on excess fees either to refund or for adjustment in the next semester**

The 20th Senate meeting approved to refund double fee payment made through loan due to late sanction of loan by the bank. For little excess money credited in the student account, the Senate directed not to refund but to get adjusted in the next semester fee payment.

ITEM NO. 20.10: **To discuss on cancellation of Mr. Ingudam Bidyasagar's (15PCE004) admission**

The 20th Senate meeting directed that a letter may be served to Mr. Ingudam Bidyasagar (15PCE004) as an ultimatum from the Administration side.

ITEM NO. 20.11: **To discuss on cancellation of Mr. Ningombam Bikramjit, 18407001, PhD student**

The 20th Senate meeting approved to cancel the Ph.D seat of Mr. Ningombam Bikramjit on the ground that the student has not reported to his supervisor and department from 28/08/2019 till the date of the above meeting and above all he has not registered since ODD 2020 Semester (January).

ITEM NO. 20.12: **To discuss the academic calendar for (Aug- Dec), 2021**

The 20th Senate meeting approved the Academic Calendar for (Aug-Dec), 2021 and SOPs along with Academic Calendar for B.Tech 1st year students (2nd Semester) which are appended at **Annexure –2** and **Annexure-3**.

ITEM NO. 20.13: **To discuss for the provision to PhD student getting scholarship from project after his/her project completion**

The 20th Senate meeting deliberated to treat on case to case basis on the genuine credentials of the students (JRF) [GATE/NET] and availability of supernumerary seats.

ITEM NO. 20.14: **Discussion on the issuance of Certificates by the Academic Section**

The Senate deliberated that the matter lies with the discretionary power of the Dean (Academic Affairs).

ITEM NO. 20.15: **To consider and approve of courses/training under NEP and to provide remuneration for NIT staff who are involved in NEP**

The 20th Senate meeting recommended to provide remuneration to resource person from the funds collected as participation fees. The Senate directed to come up with detailed course structure (duration) with respect to the courses/training proposed under NEP-2020 in the next Senate meeting.

ITEM NO. 20.16: **To consider to approve to change the subject name "Electronics and Electrical Measurement and instrumentation Lab. (Electives) to Electronics, Electrical & Instrument measurement Lab. for ECE Department**

The 20th Senate meeting approved to change the subject name "Electronics and Electrical Measurement and instrumentation Lab. (Electives) to Electronics, Electrical & Instrument measurement Lab.

ITEM NO. 20.17: **To discuss on Civil M. Tech course approval**

The 20th Senate meeting gave the Ex-Post facto approval for Courses under Major/Electives for M.Tech programme in Civil Engineering Department which is given below:

Sl. No.	Course Title /Code	Rem.
1.	ADVANCED FLUID MECHANICS	(3-0-2-8)
2.	FLUVIAL HYDRAULICS	(3-0-0-6)
3.	ECOHYDROLOGY & ECOHYDRAULICS	(3-0-0-6)
4.	GEOSPATIAL HYDROLOGY & CLIMATE CHANGE	(3-0-2-8)
5.	GEOINFORMATICS FOR DISASTER MANAGEMENT (GeoDM)	(3-0-0-6)
6.	GEOMATICS in URBAN ANALYSIS	(3-0-0-6)
7.	THERMAL MICROWAVE & HYPERSTECTRAL REMOTE SENSING	(3-0-2-8)
8.	GROUNDWATER ENGINEERING	(3-0-0-6)

ITEM NO. 20.18: **To consider to float new electives for M.Tech programme in Civil Engineering Department**

The 20th Senate meeting approved in floating of new electives for M.Tech programme which are given below:

CE 510: Biological Processes in Environmental Engineering (3-0-0-6)
CE 512: Environmental Systems Engineering Laboratory (1-0-4-6)
CE 514: Industrial Waste water Pollution Control (3-0-0-6)

The detailed new electives of M.Tech programme in Civil Engineering are appended at **Annexure – 4.**

ITEM NO. 20.19: **To consider and permit to have more guest faculty for Mathematics Department**

The 20th Senate meeting recommended to fix Rs.1500/- per lecture with a maximum of Rs 20,000 per month and Rs.60, 000/- per semester (as maximum class is 40 lectures per semester) as remuneration to the Guest Lecturer subject to approval of the Finance Committee and BoG of the institute. The Senate also recommended to engage Guest Lecturer based on the work load of 4 regular faculty members, who are taking B.Tech and M.Sc classes.

ITEM NO. 20.20: **To seek permission in converting regular to part-time PhD by Mr. Oinam Vivek Singh (Enrolment No. 17403003)**

The 20th Senate meeting approved in permitting Mr. Oinam Vivek Singh (Enrolment No. 17403003) of CSE Department to convert from regular to part-time Ph.D category.

ITEM NO. 20.21: **To consider in permitting MSc students (Gate & Non Gate) to apply for admission in M. Tech programme in the ECE department**

The 20th Senate meeting approved in permitting MSc students (Gate & Non Gate), who have completed M.Sc in relevant fields based on CCMT.

ITEM NO. 20.22: **To consider in reconstructing M. Tech degree with revision of syllabus of ECE Department**

The 20th Senate meeting approved the proposed revised M.Tech syllabus with degree in Electronics and Communication Engineering from VLSI which is appended at **Annexure-5**.

ITEM NO. 20.23: **To consider in permitting continuing supervision of PhD students for Dr. Kundan Kumar, Asst. Prof., EE Department from his previous institute**

The 20th Senate meeting approved in permitting continuing supervision of Ph.D students (viz., Mr. VVSR Chowdary Kantipudi, Roll. No. 1881078 and Ms. Snehalika, Roll No. 1981195) of Dr. Kundan Kumar, Asst. Professor, EE Department from his previous institute i.e, Kalinga Institute of Industrial Technology, Deemed to be university (KIIT DU, Bhubaneswar)

ITEM NO. 20.24: **Discussion on update in category**

The Senate has no say in this matter. It has directed to refer to Social Welfare Department, Government of Manipur.

ITEM NO. 20.25: **To discuss on cancellation of Mr. Songbiakthang Hangsing, (17403004), PhD student**

The 20th Senate meeting approved to cancel/terminate the Ph.D seat of Mr. Songbiakthang Hangsing, (17403004).

ITEM NO. 20.26: **Any other items with the permission of the Chair**

The meeting ended with vote of thanks to the Chair.

(Prof. Kh. Manglem Singh)
Registrar (i/c),
Secretary, Senate
National Institute of Technology Manipur

Prof. (Dr.) Goutam Sutradhar
Director, NIT Manipur
Ex-Officio Chairman, Senate
National Institute of Technology Manipur

ANNEXURE - 1

Enrolment coding is given as: **A B C D E F G H**

a) First and Second digit (AB): Year of registration

b) Third digit (C): Degree Code

- 1- B.Tech
- 2- Mtech
- 3- MSc
- 4- PhD

c) Fourth and Fifth (DE): Branch Code

- 01- Civil Engineering
- 02- Chemistry
- 03- Computer Science and Engineering
- 04- Electrical Engineering
- 05- Electronics and Communication Engineering
- 06- Humanities and Management
- 07- Mechanical Engineering
- 08- Mathematics
- 09- Physics

d) Sixth, Seventh and Eighth(FGH) : Roll Number of the student

Example: '21101023'- (21)- Student enrolled in 2021,(1)- B.Tech student, (01)-Civil Engineering and Roll No 023

ANNEXURE-2

Academic Calendar August – December 2021
(Classes may be Online /Offline as per Ministry SOPs due to Covid-19)

National Institute of Technology Manipur

SN	Name	:	Semester (August – December)
1	Registration of all continuing UG, PG & PhD students	:	26th-30th July 2021
2	Classes started for All continuing students	:	26th July, 2021
3	Registration of new BTech students	:	As per CSAB/JoSAA
4	Registration of new MTech/MSc students	:	As per CCMT/CCMN
5	Registration of new PhD students	:	26th – 30th July 2021
6	First instruction day for Fresh B.Tech students	:	As per CSAB/JoSAA
7	Mid Semester Examination (MSE) Theory	:	27th – 01st October 2021 Monday - Friday
8	I- Project/Thesis Review of MTech/MSc	:	On or before 24th September 2021 Friday
9	Last day of Instruction	:	20th November 2021 Friday
10	Laboratory End Semester Examination	:	8th Nov–12th November 2021 Monday-Friday (in between classes will be there)
11	End Semester Examination (ESE) Theory	:	22nd November– 26th Nov 2021 Monday-Friday
12	II - Project/Thesis Review of MTech/MSc	:	On or before 3rd December 2021 Friday
13	Last date for showing evaluated ESE answer scripts to the BTech students	:	Before 13th December 2021, Monday
14	Last date of submission of grades to Academic Section	:	15th December 2021 Wednesday

ANNEXURE-3

SOPs for B.Tech 1st Year Students- 2nd Semester 2020-2021

1. There will be no Physical Class for 2nd semester, B.Tech March –July 2020-2021 academic session.
2. Physical Classes and Examination if required any, will be intimidated after the approval by the competent authority

3. Academic calendarfor 2nd semester B.Tech students (March 2021- July 2021)

S.N.	Detail	Date
1	Registration of 2nd semester	22nd – 26thMarch 2021
2	Starting of Online Classes	22nd March 2021
3	Mid Semester Examination (MSE) Theory	10th – 14th May 2021
4	Last day of instruction	18th June 2021
5	Laboratory End Semester Examination	14th – 18th June 2021
6	End Semester Examination (ESE) Theory	21st June – 2th July 2021
7	Last date for showing evaluated ESE answer scripts to the B.Tech Students	13th July 2021
8	Last date of submission of grades to Academic Section	16th July 2021

4. Time Tables

B.Tech Semester II - Group I **March 2021**

Day	900-1000	1000-1100	1100-1200	1200-1300	1-2 PM	1400-1500	1500-1600	1600-1700
M	CS101	MA101	PH101,	LUNCH		EE111,		
T	CS101	MA101	PH101,			EE111,		
W	CS101	EE101	PH101,			CS111/PH111		
T	EE101	CE101	PH101, (Tut)			CS111, /PH111		
F	CE101	EE101	MA101			NSS/Sport, Tha/Seminar		

B.Tech Semester II - Group II

Day	900-1000	1000-1100	1100-1200	1200-1300	1-2 PM	1400-1500	1500-1600	1600-1700
M	MA101	HS101	ME101	LUNCH		CH111, Lab, A		
T	MA101	EC101	ME101			CH111, Lab, B		
W	CH101	EC101	ME101			ME112 (L)	NSS/Sport, Tha/Seminar	
T	CH101	EC101	ME101 (Tut)			ME111 /ME112		
F	CH101	MA101	HS101			ME111 /ME112		

Any Notice change in time table by the concern faculty may be brought to the office of Dean AA.

SN	Code	Subject name
1	MA101	Engineering Mathematics I
2	CH101	Engineering Chemistry
3	HS101	Communication Skills
4	EC101	Basic Electronics Engineering
5	ME101	Engineering Mechanics
6	CH111	Engineering Chemistry Lab
7	ME111	Workshop
8	ME112	Engineering Drawing
9	SA101	NSS/NCC/NSOI

Code	Subject name
CS101	Introduction to Computing
MA101	Engineering Mathematics I
EE101	Basic Electrical Engineering
CE101	Environmental Studies
PH101	Engineering Physics I
EE111	Basic Electrical Engineering Lab
CS111	Introduction to Computing Lab
PH111	Engineering Physics I Lab
SA101	NSS/NCC/NSOI

5. Examination and Mark Distribution:

(i.) **Theory Paper:**(a) Unit Test: 20 marks (b) Mid Term: 10 (students conduct) + 10 (Viva) + 10 (Exam) = 30 marks (c) End term: 10 Marks (Conduct) + 20 (Theory) + 20 (Viva). Average of best two unittest will be considered.

(ii.) Practical Paper:10 (Record + Attendance) + 20 (Exam) + 20 (Viva)

6. All examination will be conducted online.

Sd/-

Dr.P. Albino Kumar

Dean (Academic & Affairs)

CE 510: Biological Processes in Environmental Engineering (3-0-0-6)

Microbiological concepts: cells, classification and characteristics of living organisms, reproduction, metabolism – basic metabolic models, microbial growth kinetics; Chemistry of carbohydrates, proteins, fats and lipids; Theory and design of biological unit operations: aerobic suspended growth systems – activated sludge processes and its modifications, ponds and lagoons; aerobic attached growth systems; anaerobic suspended and attached systems; Biological nutrient removal; Sequential Batch Reactors; Theory and design of sludge treatment; Wastewater disposal systems.

Text Books:

1. Pelczar, M. J. (Jr), Chan, E C S and Krief, N. R., Microbiology, 5 th Ed., McGraw-Hill, 1996.
2. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4 th Edition, 2003.
3. Henze, M., Harremoes, P., Jansen, J. C. and Arvin, E., Wastewater Treatment: Biological and Chemical Processes, 3 rd Ed., Springer Verlag, 2002.

Reference Books:

1. Heritage, J., Evans, E. G. V. and Killington, R. A., Introductory Microbiology, Cambridge Univ. Press, 1996.
2. Benefield, L. D. and Randall, C. W., Biological Principles in Wastewater Treatment, PrenticeHall, 1980.
3. Grady, C. P. L., Daigger, G. T. and Lim, H. C., Biological Wastewater Treatment, Marcel Dekker, Inc., New York, 2 nd Edition, 1999.
4. Arceivala, S. J., Wastewater Treatment for Pollution Control, Tata McGraw Hill, 1999.

CE 512: Environmental Systems Engineering Laboratory (1-0-4-6)

Detailed laboratory exercises related with physico-chemical and biological processes in Environmental Engineering: Sedimentation, Jar Test, Filtration, Chlorination, Adsorption and Ion Exchange (Batch and Column), Gas Transfer, Reaction Kinetics; Activated Sludge, Batch Anaerobic Reactor etc.

Texts/References:

1. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 1998, 20 th Ed.
2. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4 th Edition, 2003.

3. Droste, R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 1996.
4. Benefield, L. D., Judkins, J. F. and Weand, B. L., Process Chemistry for Water and Wastewater Treatment, Prentice Hall, 1982.
5. Drum, D. A., Bauman, S. L. and Shugar, G. J., Environmental Field Testing and Analysis Ready Reference Handbook, McGraw Hill, 2000.

CE 514:Industrial Wastewater Pollution Control (3-0-0-6)

Industrial wastewater versus municipal wastewater; Effects of industrial wastewater on receiving water bodies and municipal wastewater treatment plant; Bioassay test; Sampling techniques; Stream protection measures; Volume reduction, strength reduction, Neutralization, Equalization, Proportioning; Combined treatment of raw industrial wastewater with domestic sewage; Zero discharge concepts; Removal of specific pollutants in industrial effluents, e.g. oil & grease, phenol, cyanide, toxic organics, heavy metals; Characteristics and treatment of various industrial effluents.

Text Books:

1. Nemerow, N. L and Dasgupta, A., Industrial and Hazardous Waste Treatment, Van Nostarnd Reinhold (New York), 1988.
2. Eckenfelder, W. W., Industrial Water Pollution Control, McGraw-Hill, 2000.
3. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4 th Edition, 2003.

Reference Books:

1. Nemerow, N. L., Zero Pollution for Industry: Waste Minimization through Industrial Complexes, John Wiley & Sons, 1995.
2. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D., Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 20 th Ed., 1998.

Department of Electronics & Communication Engineering
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PROPOSED SYLLABUS FOR M.TECH. IN ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER-I

Course Code	Course Title	L	T	P	C
EC 501	Analog and Digital CMOS IC Design	3	0	0	6
EC 503	Embedded Systems Design	3	0	0	6
EC 505	Modern Wireless Communication	3	0	0	6
EC 507	Signal Processing Algorithms	3	0	0	6
EC 5xx	Elective-I	3	0	0	6
EC 51x	Elective-II (Laboratory Course)	0	0	3	3
		Total:			33

SEMESTER-II

Course Code	Course Title	L	T	P	C
EC 502	Semiconductor IC technology	3	0	0	6
EC 504	Advanced Digital Communication	3	0	0	6
EC 506	Advance Microwave Engineering	3	0	0	6
EC 5xx	Elective-III	3	0	0	6
EC 51x	Elective-IV(Laboratory Course)	0	0	3	3
		Total:			27

SEMESTER-III

Course Code	Course Title	L	T	P	C
EC 611	Project-I	0	0	24	24
		Total:			24

SEMESTER-IV

Course Code	Course Title	L	T	P	C
EC 612	Project-II	0	0	24	24
		Total:			24

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Students should select subjects either from Elective A or B.

List of Electives A

Electives-I

Course Code	Course Title	L	T	P	C
EC 521	Digital System Design	3	0	0	6
EC 523	Signal Processing for Embedded Systems	3	0	0	6
EC 525	Real Time Operating Systems	3	0	0	6
EC 527	Microcontroller for Embedded Systems	3	0	0	6
EC 529	Embedded Networking	3	0	0	6
EC 531	FPGA Design	3	0	0	6
EC 535	VLSIDSP	3	0	0	6
EC 537	Digital IC Design	3	0	0	6
EC 539	MEMS and Microsystem Technology	3	0	0	6
EC 541	Biomedical Signal and Systems	3	0	0	6

Electives-II

Course Code	Course Title	L	T	P	C
EC 511	VLSI and Embedded Lab-I	0	0	3	3
EC 513	Signal and Image Processing Lab	0	0	3	3

Electives-III

Course Code	Course Title	L	T	P	C
EC 524	Modeling of Semiconductor Devices	3	0	0	6
EC 526	ASIC Design and Modeling	3	0	0	6
EC 528	Embedded Computing	3	0	0	6
EC 530	Low Power VLSI	3	0	0	6
EC 532	VLSI System Design	3	0	0	6
EC 534	VLSI EDA Tools	3	0	0	6
EC 536	Reconfigurable Computing	3	0	0	6
EC 538	Memory Technologies	3	0	0	6
EC 540	Filter Design	3	0	0	6
EC 542	CPLD & FPGA Architecture	3	0	0	6

Electives-IV

Course Code	Course Title	L	T	P	C
EC 512	VLSI and Embedded Lab-II	0	0	3	3
EC 514	System Simulation Lab-A	0	0	3	3

Students should select subjects either from Elective A or B

List of Electives A

Electives-I

Course Code	Course Title	L	T	P	C
EC 521	Digital System Design	3	0	0	6
EC 523	Signal Processing for Embedded Systems	3	0	0	6
EC 525	Real Time Operating Systems	3	0	0	6
EC 527	Microcontroller for Embedded Systems	3	0	0	6
EC 529	Embedded Networking	3	0	0	6
EC 531	FPGA Design	3	0	0	6
EC 535	VLSIDSP	3	0	0	6
EC 537	Digital IC Design	3	0	0	6
EC 539	MEMS and Microsystem Technology	3	0	0	6
EC 541	Biomedical Signal and Systems	3	0	0	6

Electives-II

Course Code	Course Title	L	T	P	C
EC 511	VLSI and Embedded Lab-I	0	0	3	3
EC 513	Signal and Image Processing Lab	0	0	3	3

Electives-III

Course Code	Course Title	L	T	P	C
EC 524	Modeling of Semiconductor Devices	3	0	0	6
EC 526	ASIC Design and Modelling	3	0	0	6
EC 528	Embedded Computing	3	0	0	6
EC 530	Low Power VLSI	3	0	0	6
EC 532	VLSI System Design	3	0	0	6
EC 534	VLSI EDA Tools	3	0	0	6
EC 536	Reconfigurable Computing	3	0	0	6
EC 538	Memory Technologies	3	0	0	6
EC 540	Filter Design	3	0	0	6
EC 542	CPLD & FPGA Architecture	3	0	0	6

Electives-IV

Course Code	Course Title	L	T	P	C
EC 512	VLSI and Embedded Lab II	0	0	3	3
EC 514	System Simulation Lab-A	0	0	3	3

Department of Electronics & Communication Engineering
राष्ट्रीय प्रौद्योगिकी संस्थान,मणिपुर
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(An Autonomous Institute under MHRD, Govt. of India)

Detailed Syllabus and Course Outcomes:

EC 501	Analog and Digital CMOS IC Design	3	0	0	6
Course Outcome	EC501.1: Able to carry out research and development in the area of analog and digital CMOS IC design. EC501.2: Design various combinational and sequential Circuits using CMOS logic. EC501.3 To be well versed with the MOS fundamentals, small signal models ,large signal models and analysis of MOSFET based circuits. EC501.4: Obtain the design of the biasing circuits for CMOS amplifiers. EC501.5: Able to analyze and design analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Current amplifiers, Cascode amplifiers, Biasing circuits.				
	MOS Switch, MOS Diode/ Active Resistor, Current Sinks & Sources, Current Mirror, Current & Voltage Reference, Band gap References. Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifier Architectures. Buffered Opamp. High Speed/Frequency Opamps, Differential Output Opamps, Micro power Op amps, Low Noise Opamp. Low Voltage Opamp, Macro models for Opamps. Sequential Ckts. Design of FSM, Moore & Mealy machines. Metastability, Solutions to metastability, Synchronization methods, VHDL codes for complex sequential machines, Hazards, Types of hazards, Method to eliminate hazards, case studies. CMOS parasitic, Technology scaling, Lambda parameter, Design calculations for different logic ckts, Calculations for Area on chip, Power dissipation, PDP, Transmission gate, Domino logic, NORA logic, CMOS layout techniques, Transient response, Advance trends of elements & Alloys for ultra fast logic ckts. **Texts :** 1. J.M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003 2. N.H.E. Weste and K. Eshraghian, Principles of CMOS VLSI Design – a System Perspective, 2nd ed., Pearson Education Asia, 2002 3. S.M. Kang and Y. Leblevici, CMOS Digital Integrated Circuits Analysis and Design, 3rd ed., McGraw Hill, 2003 4. J. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons (Asia) Pte Ltd, 2002 5. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997. 6. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001 7. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997 8. B. Razavi, RF Microelectronics, Prentice-Hall, 1998. 9. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001. 10. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.				
EC 502	Semiconductor IC technology	3	0	0	6
Course Outcome	EC502.1:Acquire knowledge about physics involved in modelling of semiconductor device. EC502.2: Learn the basics theory of Crystal Growth and Wafer Preparation. EC502.3: Study the Epitaxy, Diffusion, Oxidation, Lithography and Etching. EC502.4: Understand the basic steps of fabrication of semiconductor devices.				
	Historical perspective, processing overview, crystal growth, wafer fabrication and basic properties of Silicon Wafers, Clean Rooms, Wafer Cleaning, Epitaxy, Thermal Oxidation of Silicon, Lithography, Wet and Dry Etching, Thin film deposition, Diffusion, Ion Implantation, Metallization, Process Integration: Passive components, Bipolar Technology, MOSFET Technology, MESFET Technology, MEMS Technology, IC Manufacturing: Electrical Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip.				

	Texts: 1. G. S. May and S. M. Sze, Fundamentals of Semiconductor Fabrication, Wiley India, 2004. 2. J. D. Plummer, M. D Deal and P. B. Griffin, Silicon VLSI Technology, Fundamentals, Practice and Modeling, Pearson education, 2000. 3. S. M. Sze, VLSI Technology, 2nd Edn., TMH, 2004. 4. S. M. Sze, Semiconductor Devices: Physics and Technology, 2nd Edn., Wiley India, 2011. 5. W. R. Runyan and K. E. Bean, Semiconductor Integrated Circuit Processing Technology, Addison Wesley Publishing Company, 1990 6. S. A. Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford University Press, 1996. 7. M. J. Madou, Fundamentals of Micro fabrication, 2nd Edition, CRC Press, 2011.				
EC 503	Embedded Systems Design	3	1	0	6
Course Outcome	EC503.1: Understand hardware and software design requirements of embedded systems. EC503.2: Describe the differences between the general computing system and the embedded system EC503.3:Develop familiarity with tools used to develop in an embedded environment. EC503.4:Analyze the embedded systems' specification and develop software programs				
	Digital Systems and Embedded Systems, Design Methodology, Design Metrics, Specialties, Concepts & types of Memory, Cache Memory, Cache mapping techniques, replacement policies, Cache wire Techniques, Cache Impact on system Performance, Integrated Circuits Technologies- Full custom/VLSI, Logic Families, ASICs , PLDs, PALs, CPLDs , FPGA, Packaging and Circuit Boards, Interconnection and Signal Integrity , Differential Signaling. General Purpose Processor, System On chip, Embedded Computer Organization, ARM 7/ARM 9 architecture, ARM Microcontrollers and Processor Cores, Instructions and Data handling, interfacing with Memory, Interrupts, Timers, ARM Bus. I/O Devices, Controllers, Simple & Autonomous I/O Controllers, Parallel, Multiplexed, Tristate, and Open-Drain Buses, Bus Protocols, Serial Transmission Techniques & Standards, Wireless protocols, CAN & advanced Buses. Design Methodology, Design Flow, Architecture Exploration, Functional Design, Functional Verification, Synthesis, Physical Design, Design Optimization, Area Optimization, Timing Optimization, Power Optimization, Design for Test , Fault Models and Fault Simulation, Scan Design and Boundary Scan, Built-In Self Test (BIST), Nontechnical Issues. **Texts/References:** 1. Digital Design: An Embedded Systems Approach Using Verilog, Peter J. .Ashenden ELSEVIER, Morgan Kaufmann Publication, 2008. 2. Data books of ARM7/ARM9 J. Staunstrup and W. Wolf, editors, Hardware/Software Co-Design: Principles and Practice, Kluwer Academic Publishers, 1997. 3. G. DeMicheli, R. Ernst, and W Wolf, editors, Readings in Hardware/Software Co-Design, Academic Press, 2002.				
EC 504	Advanced Digital Communication	3	0	0	6
Course Outcome	504.1: Understanding Concepts of Data Conversions 504.2: Learning Digital Modulations and data transmissions 504.3: Analyse concepts of Information content. 504.4: Have to concept of coding and its importance.				
	Analog-to-Digital Conversion: Sampling theorem, Pulse-Amplitude Modulation, Channel bandwidth for PAM signal, Natural sampling, Flat top sampling, Quantization of signals, Quantization error, Pulse- code modulation (PCM), Electrical representation of binary digits, The PCM system, Companding, Multiplexing PCM signals, Differential PCM, Delta modulation, Adaptive delta modulation, Vocoders, Channel Vocoder, Linear Predictive coder. Digital Modulation Techniques: Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying, Differentially-Encoded PSK (DEPSK), Quadrature Phase-Shift Keying (QPSK), Quadrature Amplitude Shift Keying (QASK), Binary Frequency-Shift Keying BFSK), Similarity of BPSK and BFSK. M-ary FSK, Minimum Shift Keying (MSK),				

	Data Transmission: A base band signal receiver, Probability of error, The Optimum Filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of PSK and FSK, Non-Coherent reception of FSK, PSK and QPSK, Calculation of error probability of BPSK and BFSK, Error probability for QPSK] Bit-by-bit encoding versus Symbol-by-Symbol encoding, Relationship between Bit error rate and Symbol Error rate and comparison of modulation systems. Information Theory and Coding: Discrete messages, The concept of amount of information, Entropy, Information rate, Coding to increase average information per bit, Shannon's theorem, Capacity of a Gaussian channel, Bandwidth-S/N tradeoff, use of orthogonal signals to attain Shannon's limit, Efficiency of orthogonal signal transmission, Coding: Parity check bit coding for error detection, Coding for error detection and error correction, Block codes (coding and decoding), Convolution codes (coding and decoding). **Text/References:** 1. Wayne Tomasi, "Electronic communications systems" 5th edition Pearson Educaion Asia, 2006 2. Taub and Schilling, "Principles of Communication Systems", TMH, 2nd Edition, 2006 3. S. Haykin, "Digital Communication", Wiley, 2006. 4. S. Haykin, "Analog and Digital Communication", Wiley.

EC 505	Modern Wireless Communication	3	0	0	6
Course Outcome	505.1: Understanding the historical background of wireless communication and its evolution. 505.2: Assimilating the concepts of increasing system capacity. 505.3: Learning the effects of fading channels and various cellular interferences. 505.4: Enquiry to latest cellular technologies.				
	Cellular concepts, frequency reuse, co channel interference, Cell splitting. Radio propagation characteristics; models for path loss, shadowing and multipath fading (delay spread, coherence bandwidth coherence time, Doppler spread); Jakes' channel model. Digital modulation for mobile radio; analysis under fading channels; diversity techniques and Rake demodulator. Introduction to spread spectrum communication. Multiple access techniques used in mobile wireless communications: FDMA/TDMA, CDMA. ;The cellular concept; Frequency reuse; the basic theory of hexagonal cell layout; spectrum/efficiency, FDM/TDM Cellular systems; channel allocation schemes. Handover analysis. Cellular CDMA; soft capacity. Erring capacity comparison of FDM/TDM systems and cellular CDMA. Discussion of GSM standards; signaling and call control; mobility management; location tracing. Wireless data networking; packet error modeling on fading channels, performance analysis of link and transport layer protocols over wireless channels; mobile data networking (mobile IP); wireless data in GSM, IS-95, and GPRS. **Texts/Rferences:** 1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education, 2003. 2. William Stallings, "Wireless Communications and Networks", Pearson Education, 2002. 3. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", First Edition, Pearson Education, 2003. 4. Uwe Hansmann, Lothar Merk, Martin S. Nicklous and Thomas Stober, "Principles of Mobile Computing", Springer, 2003. 5. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.				
EC 506	Advance Microwave Engineering	3	0	0	6
Course Outcome	EC506.1: Student should able to identify the basic microwave devices. EC506.2: Student should able to differentiate microwave devices for different frequency bands application under the microwave frequency range.				

	EC506.3: Student should able to understand the working principle of the microwave devices. EC506.4: Student should able to implement the new microwave devices for practical applications.				
	Significance of Maxwell Equations, Theory of Transmission line, Principles of microwave circuits, Wave guides and boundary conditions, Cavity resonators, Directional couplers, Phase shifter, microstrip line, Various types of antennas and feed systems, Antenna measurement principles, MICs, antenna, stub matching, smith chart, Noise and None linear distortion: Noise in Microwave Circuits, Noise Figure, Nonlinear Distortion, Dynamic Range. **Text/References:** 1. B. Razavi, IEEE Press 1995. 2. D. M. Pozar, "Microwave Engineering," 4th Edition, Wiley, 2012. 3. Elements of Electromagnetics, 4th Edition – Matthew N O Sadiku Oxford University Press 4. Engineering Electromagnetics, 2ed Edition - Nathan Ida Springer India				
EC 507	Signal Processing Algorithms	3	0	0	6
Course Outcome	507.1: Summarize various Transforms like DFT, DCT, HAAR etc on 1-D and 2-D signals 507.2: Apply such transforms to design Digital filters (FIR/IIR) 507.3: Analyze the filter structures using realization techniques for computation and design efficiency 507.4: Monitor the accuracy of Digital filters in Multi-rate signal processing				
	Orthogonal transforms: DFT, DCT and HAAR; Properties of DFT; Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency; Linear convolution using DFT; Digital filter structures: Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel all pass realization of IIR transfer functions, Sine cosine generator; Computational complexity of filter structures; Multirate signal processing: Basic structures for sampling rate conversion, Decimators and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures; Computationally efficient sampling rate converters; Arbitrary sampling rate converters based on interpolation algorithms: Lagrange interpolation, Spline interpolation; Quadrature mirror filter banks; Conditions for perfect reconstruction; Applications in sub-band coding **Texts:** 1. R. Chassaing and D. Reay, Digital signal processing and applications with TMS320C6713 and TMS320C6416, Wiley. 2008. 2. S. K. Mitra, Digital Signal Processing: A Computer Based Approach,3rd Edn., TMH, 2008. 3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Prentice Hall, 2007.				

EC 521	Modern Digital System Design	3	0	0	6
Course Outcome	EC521.1: Design Mealy and Moore finite state machines for the given specifications. EC521.2: Understand the overview of clock skew concept. EC521.3: Understand overview of PLDs, CPLDs and FPGAs. EC521.4:Use hardware description language and logic simulation tools.				
	Principles of Sequential logic design: Concept of FSM - Metastability, State machine structures: Moore machine - Mealy machine, Analysis of state machine with D and J-K Flip-flops, Clocked synchronous state machine design, Designing state machine using state diagrams, State machine synthesis using transition list, Clock skew, Overview of PLDs, CPLDs and FPGAs, RT level combinational circuit, Regular sequential circuit, Design examples with VHDL. **Texts:** 1. J. F. Wakerly: Digital Design-Principles and Practices, 4th Edition, Pearson, 2008. 2. Pong P. Chu: FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version, 1st Edition, WileyInterscience, 2008.				
EC 523	Signal Processing for Embedded Systems	3	0	0	6

Course Outcome	523.1: Illustrate various signal processing algorithms and transforms 523.2: Organize DSP algorithms using flow graph representations 523.3: Integrate transforming techniques like folding/ unfolding, retiming, parallel processing to achieve faster computations and better efficiency 523.4: Judge the performance of the algorithms using various DSP processor architectures				
	Digital Signal Processing Overview, Convolution, Correlation, Digital filters, DFT, STFT, DCT, wavelets and filter banks, FFT algorithms and Implementation, Representations of the DSP algorithms, Block diagrams, Signal flow graph, Data-flow graph, Dependence graph, iteration bounds, Pipelining and Parallel processing of FIR filters, Algorithm transformation: Retiming , Folding, Unfolding, Algorithmic strength reduction in Filters and Transforms, Parallel FIR filters, Fast FIR algorithms, Discrete cosine transform and Inverse DCT, Parallel processing for IIR filters, Pipelined adaptive digital filters. Introduction to Digital signal processing systems. MAC, Barrel shifter, ALU, Multipliers, Dividers, DSP processor architecture, Software developments, Selections of DSP processors, real time implementation considerations, Hardware interfacing. DSP processor architectures: TMS 320C54XX, TMS 320C67XX, Blackfin processor: Architecture overview, memory management, I/O management, On chip resources, programming considerations, Real time implementations. Applications of DSP systems: FIR filters, IIR filters, DTMF generation and detection, FFT algorithms, wavelet algorithms, Adaptive algorithms: system identification, inverse modeling, noise cancellation, prediction. **Texts:** 1. Sen M. Kuo and Woon-Seng Gan, "Digital Signal Processors, architectures, implementations, and applications", Prentice-Hall, 1999. 2. V. Madisetti, " The Digital Signal Processing Handbook", IEEE press, 2000 3. K. K. Parhi, "VLSI Digital Signal Processing Systems- Design and Implementation", John Wiley & Sons, Inc, 2008. 4. Sanjit K. Mitra, " Digital Signal Processing: A Computer based approach", McCraw Hill, 1998. 5. Lawrence R. Rabiner and Bernard Gold, "Theory and application of Digital signal Processing", Prentice-Hall of India, 2006.				
EC 524	Modeling of Semiconductor Devices	3	0	0	6
Course Outcome	EC524.1: Describe the properties of materials and Application of semiconductor electronics EC524.2: Apply the knowledge of semiconductors to illustrate the functioning of basic electronic devices. EC524.3: Demonstrate the control Applications using semiconductor devices. EC524.4: Identify the fabrication methods of integrated circuits				
	p-n Junctions: equilibrium conditions, forward and reverse-biased junctions, reverse-bias breakdown, transient and a-c conditions, recombination and generation in the transition, semiconductor hetero-junctions, Metalsemiconductor junctions: Schottky barriers, rectifying and Ohmic contacts, Bipolar junction transistors: minority carrier distribution and terminal currents, generalized biasing, switching, secondary effects, frequency limitations of transistors, hetero-junction bipolar transistors, Field-Effect Transistors: JFETcurrent- voltage characteristics, effects in real devices, high-frequency and high-speed issues, Metal Insulator Semiconductor FET, MOSFETbasic operation and fabrication, ideal MOS capacitor; effects of real surfaces, threshold voltages; output and transfer characteristics of MOSFET, short channel and Narrow width effects, MOSFET scaling, Optoelectronics Devices: Light emitting diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells, SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2 and level 3 model, Model parameters: SPICE models of p-n diode and BJT. **Texts:** 1. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th Edition, PHI Private Limited, 2011. 2. P. Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edition, PHI, 2009.				

3. G. Massobrio and P. Antognetti, Semiconductor Device Modeling withSPICE, 2nd Edition, TMH, 2010.
4. C. C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson Education, 2010.
5. R. S. Muller and T. I. Kamins, Device Electronics for Integrated Circuits, 3rd Edition, Wiley India, 2009.
6. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, 3rd Edition, Wiley India, 2010.
7. Y. Tsividis, Operation and Modeling of the MOS transistor, 2nd Edition, TMH, 1999.
8. S. A. Neamen and D. Biswas, Semiconductor Physics and Devices, 4th Edition, TMH, 2012.

EC 525	Real Time Operating Systems	3	0	0	6
Course Outcome	525.1 Understand the fundamentals of interaction of OS with a computer and User computation 525.2 Recognize how process are created and controlled with OS 525.3 Learn the programming logic of modelling Process based on range of OS features 525.4 Understand the development of the target system by porting RTOS				
	Software Architectures, Software Developments Tools, Programming Concepts, Embedded Programming in C and C++, Queues, Stacks, Optimization of Memory needs, Program Modeling Concepts, Software Development Process Life Cycle and its Model, Software Analysis, Design and Maintenance, Operating System Concepts, Processes, Deadlocks, Memory Management, Input /Output, Files, Security, the Shell, Recycling of Concepts. Operating system structure Monolithic Systems: Layered Systems, Virtual Machines, Exo-kernels, Client-Server Model.Real Time Operating Systems (µC/OS):Real-Time Software Concepts, Kernel Structure, Task Management, Time Management, Inter task Communication & Synchronization, Memory Management, and Porting µCos-II. Linux/RT Linux: Features of Linux, Linux commands, File Manipulations, Directory, Pipes and Filters, File Protections, Shell Programming, System Programming, RT Linux Modules, POSIX Threads, Mutex Management, Semaphore Management **Texts:** 1. µC/OS-II, The real time Kernel, Jean J. Labrossy, Lawrence: R & D Publications, 2000. 2. Embedded Real Time Systems: Concepts, Design & Programming, Dr.K.V.K.K. Prasad, Dreamtech Publication, 2007 3. An Embedded Software Primer, David E. Simon, Pearson Education Publication, 2005. 4. Modern Operating Systems, Second Edition, Andrew S. Tanenbaum, Prentice Hall Publication, 2001. 5. Embedded Systems Architecture, Programming and design, Raj Kamal, Tata MCgraw-Hill Publication, 1999.				
EC 526	ASIC Design and Modeling	3	0	0	6
Course Outcome	EC526.1: Describe the design flow, types and the programming technologies of an ASIC and its construction EC526.2: Describe the goals, objectives, measurements and algorithms of floorplanning & placement then apply those algorithms to place the logic cells inside the flexible blocks of an ASIC to meet the objectives EC526.3: Describe the goals, objectives, measurements and algorithms of routing then apply those algorithms to route the channels then describing various circuit extraction formats and investigate the issues and discover solutions in each step of physical design flow of an ASIC. EC526.4: Design an ASIC for digital circuits with ASIC design flow steps consists of simulation, synthesis, floorplanning, placement, routing, circuit extraction and generate GDSII File for fabrication of an ASIC, then analyze the ASIC to meet the performance in terms of area, speed and power using EDA tools.				
	Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.				

	PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLSAND PROGRAMMABLE ASIC I/O CELLS 9 Anti fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks. PROGRAMMABLE ASIC ARCHITECUTREArchitecture and configuration of Spartan / Cyclone and Virtex / Stratix FPGAs – Micro-Blaze / Nios based embedded systems – Signal probing techniques. LOGIC SYNTHESIS, PLACEMENT AND ROUTINGLogic synthesis - ASIC floor planning- placement and routing – power and clocking strategies.				
EC 527	Microcontroller for Embedded Systems	3	0	0	6
Course Outcome	527.1 Learn the basic hardware of various microcontrollers 527.2 Program, build and test a microcontroller system 527.3 Interface a microcontroller system to user controls and other electronic systems. 527.4 Understand the internal architecture of microcontroller systems, including counters, timers, ports, and memory.				
	ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions. Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops. Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation, Access Permissions, Context Switch. **Texts/References:** 1. ARM Systems Developer's Guides- Designing & Optimizing System Software – Andrew N. Sloss, Dominic Symes, Chris Wright, 2008, Elsevier. 2. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.				
EC 528	Embedded Computing	3	0	0	6
Course Outcome	EC528.1: Understand the embedded processor architectures. EC528.2:Understand the various semiconductor memories including RAM and ROM EC528 3:Design and develop a basic embedded system by programming. EC528.4: Understand the communication protocols used in embedded systems.				
	System Calls, Scheduling, Memory Allocation, Timers, Embedded Linux, Root File System, Busy Box. Tasks, Threads, Multi-Threading, Semaphore, Message Queue. GNU GCC, make, gdb, static and dynamic linking, C libraries, compiler options, code optimization switches, lint, code profiling tools. Sensor and actuator interface, data transfer and control, GPS, GSM module interfacing with dataprocessing and display. OpenCV for machine vision, Audio signal processing. Sockets, ports, UDP, TCP/IP, client server model, socket programming. 802.11, Bluetooth, ZigBee, SSH, firewalls, network security. Application binary interface, exception and interrupt handling, interrupt latency, assemblers, assembler directives, macros, simulation and debugging tools. **Texts/References:** 1. Modern Embedded Computing - Peter Barry and Patrick Crowley, 1st Ed., Elsevier/Morgan Kaufmann, 2012. 2. Linux Application Development - Michael K. Johnson, Erik W. Troan, Adission Wesley, 1998.				

	3. Assembly Language for x86 Processors by Kip R. Irvine 4. Intel® 64 and IA-32 Architectures Software Developer Manuals 4. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin and Greg Gagne. 5. The Design of the UNIX Operating System by Maurice J. Bach Prentice-Hall 6. UNIX Network Programming by W. Richard Stevens				
EC 529	Embedded Networking	3	0	0	6
Course Outcome	529.1 Learn the serial and parallel communication protocol related to embedded networking. 529.2 Understand the concepts of USB & CAN bus. 529.3 Understand the concepts of Embedded Ethernet. 529.4 Recognize the need for wireless protocols to indulge in Real world interfacing.				
	Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming - ISA/PCI Bus protocols – Firewire. USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types – Enumeration – Descriptors –PIC 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN. Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol. Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure. Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing. **Texts/ References:** 1. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, Tony Givargis, John & Wiley Publications, 2002 2. Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port - Jan Axelson, Penram Publications, 1996. 3. Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series - Dogan Ibrahim, Elsevier 2008. 2. Embedded Ethernet and Internet Complete - Jan.Axelson, Penram publications, 2003. 3. Networking Wireless Sensors - Bhaskar Krishnamachari, Cambridge press 2005.				
EC 530	Low Power VLSI	3	0	0	6
Course Outcome	530.1: Analyze and implement various CMOS static logic circuits. 530.2: Learn the design of various CMOS Dynamic logic circuits. 530.3: Learn the design techniques of low voltage and low power CMOS circuits for various applications. 530.4: Design and implementation of various structures for low power applications.				
	Introduction: Power dissipation analysis, Physics of Power Dissipation in CMOS FET Devices, Dynamic power, Static power Low-power circuit techniques –Voltage scaling and threshold-voltage hurdle in low-power design, Low power design Using Energy Recovery Technique. Advanced Techniques - Low Power CMOS VLSI Design, Low-power circuit level and device level approach. Low-power Analog and digital design issues in weak inversion and strong inversion regions of operation. Power Estimation - Synthesis for Low Power - Design and Test of Low Voltages - CMOS Circuits. **Text/Reference:** 1. Gary Yeap " Practical Low Power Digital VLSI Design", 1997.				

	2 Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design", 2000.				
EC 531	FPGA Design	3	0	0	6
Course Outcome	EC531.1: Understand design and implementation styles. EC531.2:Use computer-aided design tools to synthesize, map, place, routing, and download the digital designs on the FPGA board. EC531.3: Identify and distinguish different special purpose processor architecture. EC531.4: Understand design of parametrized library cells.				
	Architecture vs organization, Design styles, Implementation styles, Design Examples using programmable logic devices, Design of Universal block. Design of memory, Floating point multiplier, Barrel shifter, Special purposeProcessors - Xilinx Vertex and Spartan - II; Altera FLEX 10k and other architectures. Design of parameterized library cells, Implementation and Testing- Xilinx,Actel and Altera FPGA based systems. Design - Case study. **Texts:** 1. John V.Old Field, Richrad C.Dorf, Field Programmable Gate Arrays, John Wiley1995. 2. Michel John Sebastian Smith: Application Specific Integrated Circuits, Pearson, 1997.				
EC 532	VLSI System Design	3	0	0	6
Course Outcome	EC532.1: Ability to understand the basics of system hardware design with hierarchical design. EC532.2: Ability to understand how the system components are interfaced with each other. EC532.3: Ability to know methods to handle multiple clocks in a system. EC532.4: Ability to make out differences between synchronous and asynchronous design systems. Designing of FSM and to know different strategies to assign the states.				
	Basics of system hardware design: Hierarchical design using top-down and bottom-up methodology, System partitioning techniques, interfacing between system components, Handling multiple clock domains, Synchronous and asynchronous design styles; Design of finite state machines: state assignment strategies; The Processor: Data path and Control, Enhancing performance with Pipelining, exploiting of Memory hierarchy. **Texts / References:** 1. G. De Micheli, Synthesis and Optimization of Digital Circuits, Tata McGraw-Hill, 2004. 2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 2nd Edition, Morgan Kaufmann Publishers, Inc, 1998. 3. J. Rabaey, Digital Integrated Circuits, A Design Perspective, 2nd Edition, Pearson Education, 2003. 4. H. E. Weste and K Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Eight Indian Reprint, Pearson Education, 2002. 5. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.				
EC 534	VLSI EDA Tools	3	0	0	6
Course Outcome	EC534.1: Organise the various equipments and components required for VLSI product development. EC534.2: Survey on the libraries available in the CAD tools. EC534.3: Identify Algorithms for circuit simulation. EC534.4: Understand the concepts of high level synthesis.				
	ASIC design flow, various design entries, IP cores, cross compilers, cell design, stick diagrams, synthesis, place and route, floor planning, power estimation, static timing analysis, dynamic timing analysis, antenna rules, design rule check, electric rule check, schematic rule check, Clock domain crossing check, layout verses schematic, layout techniques, verification, manufacturing tests. Xilinx ISE, Actel libero, Active HDL, Sinplify pro, Leonardo spectrum, Quartus, Boole Dozer, Model Simdesign entries, various simulation, synthesis, place and route, timing verification. Cadence, IC station – design entries, simulations, various tools in the suit, GDS files. Microwind, Spice, Magic – layout techniques, simulations, DRCs, tools available in the suit.				

	Texts: 1. Michael Smith, "Application Specific Integrated Circuits", Pearson Education Asia, 2000 2. Reference manuals of the respective tools.				
EC 535	VLSI DSP	3	0	0	6
Course Outcome	535.1: Understand the overview of DSP concepts 535.2: Perform Pipelining and parallel processing in FIR systems to achieve high speed and low power 535.33 Perform retiming, unfolding and folding in FIR and IIR filters. 535.4 4 Understand systolic architecture design for FIR filters 535.4: Learn and understand the different techniques of power reduction and power estimation.				
	Introduction to DSP systems: Representation of DSP algorithms; Iteration Bound: Definition, Examples, Algorithms for computing Iteration bound; Pipelining and Parallel Processing: Definitions, Pipelining and parallel processing of FIR filters, Pipelining and parallel processing for low power; Retiming: Definitions and Properties, Solving system of Inequalities, Retiming techniques; Unfolding: Definition, An algorithm for unfolding, Applications of unfolding; Folding: Definition, Folding transformations, Register minimization techniques, Register minimization in folded architectures; Systolic Architecture Design: Introduction, Systolic array design methodology, FIR systolic arrays, Selection of scheduling vector, Matrix-Matrix multiplication and 2D systolic array design; CORDIC based Implementations: Architecture, Implementation of FIR filter and FFT algorithm; Bit-Level arithmetic architectures: Parallel multipliers, Bit-serial multipliers, Bit-Serial FIR filter design and Implementation; Redundant arithmetic: Redundant number representation, Carry-free radix-2 addition and subtraction, radix-2 hybrid redundant multiplication architectures; Low-power design: Theoretical background, Scaling versus power consumption, Power analysis, Power reduction techniques, Power estimation approaches. Texts: 1. U. Meyer-Baese, DSP with FPGA, Springer, 2004. 2. K. K. Parhi, VLSI DSP Systems, Wiley, 2003. 3. R.G. Lyons, Understanding Digital Signal Processing, Pearson Education, 2004.				
EC 536	Reconfigurable Computing	3	0	0	6
Course Outcome	EC536.1: Understand the Concept of Reconfigurable Computing and FPGA Architectures. EC536.2: Model the digital system building blocks using the HDL Language. EC536.3: Explore the scope of reconfigurable computing in various applications. EC536.4: Analyse and optimize the various design parameters.				
	Computing requirements, Area, Technology scaling, Instructions, Custom Computing Machine, Overview, Comparison of Computing Machines. Interconnects, Requirements, Delays in VLSI Structures; Partitioning and Placement, Routing; Computing Elements, LUT's, LUT Mapping, ALU and CLB's, Retiming, Fine-grained & Coarse-grained structures; Multicontext; Comparison of different architectures viz. PDSPs, RALU, VLIW, Vector Processors, Memories, Arrays for fast computations, CPLDs, FPGAs, Multicontext, Partial Reconfigurable Devices; TSFPGA, DPGA, Mattrix; Best suitable approach for RD; Case study. Control Logic, Binding Time and Programming Styles, Overheads, Data Density, Data BW, Function density, Function diversity, Interconnect methods, Best suitable methods for RD; Contexts, Context switching; Area calculations for PE; Efficiency, ISP, Hot Reconfiguration; Case study. Architectures for existing multi FPGA systems, Compilation Techniques for mapping applications described in a HDL to reconfigurable hardware, Study of existing reconfigurable computing systems to identify existing system limitations and to highlight opportunities for research; Software challenges in System on chip; Testability challenges; Case studies. Modelling , Temporal portioning algorithms, Online temporal placement, Device space management, Direct communication, Third party communication, Bus based communication, Ckt switching, Network on chip, Dynamic network on chip, Partial reconfigurable design.				

	Texts: 1. IEEE Journal papers on Reconfigurable Architectures 2. "High Performance Computing Architectures" (HPCA) Society papers. 3. Christophe Bobda, "Introduction to Reconfigurable Computing", Springer Publication, 2009. 4. Maya Gokhale, Paul Ghaham, "Reconfigurable Computing". Springer Publication. 2011.				
EC 537	Digital IC Design	3	0	0	6
Course Outcome	537.1: Learn the basics modelling and fabrication of CMOS Integrated circuits. 537.2: learn the design of power performance tradeoff. 537.3: Design and analysis of digital integrated circuits. 537.4: Learn the basic digital logic gate and their applications				
	Introduction; Metrics; Switch Logic; Process; Gates; MOS Transistor; Inverter VTC,MOS Capacitor; Inverter Delay; Power Buffer Sizing; Wires; CMOS Logic; Logical Effort; Process variation Effects, Introduction to VLSI fabrication. Memory; Decoders; Pass Transitor; Dynamic and Static Logic; Domino Logic; Scaling; Adders; Multipiers; Latches; Timing; Clock; SRAM; Design for Performance; Power Performance Tradeoff. Analysis and Design of Digital Integrated Circuits. Circuit analysis of piecewise linear single energy storage element networks. Rules for determining states of diodes and transistors. Bipolar junction and field effect transistors as switches. Basic digital logic gates. Integrated circuit logic and building blocks (TTL, MOS, CMOS, ECL, Integrated Injection Logic). Sweep circuits (constant current, Miller, bootstrap). Monostable, Astable, and Bistable (Schmitt Trigger) switching circuits. Applications (pulse width modulator, triangle wave generator, FM function generator design). **Text/References:** 1. Ivan Sutherlnd, Robert F Sroull, David Harris, Logical Effort: Designing Fast CMOS Circuits 2. N. Weste and K. Eshranghian, Principles of CMOS VLSI Design, Addison Wesley, 1985 3. L. Glaser and D. Dobberpuhl, The Design and Analysis of VLSI Circuits, Addison Wesley, 1985 4. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979. 5. J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997				
EC 538	Memory Technologies	3	0	0	6
Course Outcome	EC538.1: Understand memory architectures of SRAM, DRAM and non-volatile memories. EC538.2: Understand memory design trade-offs. EC538.3: Examine memory fault models. EC538.4: Analyse the various advance memory technologies.				
	Static Random Access Memories (SRAMs), SRAM Cell Structures, MOS SRAM Architecture, MOS SRAM Cell and Peripheral Circuit, Bipolar SRAM, SOI, Advanced SRAM Architectures, Application Specific SRAMs; DRAMs, MOS DRAM Cell, BiCMOS DRAM, Error Failures in DRAM, Advanced DRAM Design and Architecture, Application Specific DRAM, High Density ROMs, PROMs, Bipolar & CMOS PROM, EEPROMs, Floating Gate EPROM Cell, OTP EPROM, EEPROMs, Nonvolatile SRAM, Flash Memories, RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing. General Reliability Issues, RAM Failure Modes and Mechanism, Nonvolatile Memory, Reliability Modeling and Failure Rate Prediction, Reliability Screening and Qualification, Radiation Effects, SEP, Radiation Hardening Techniques, Process and Design Issues, Radiation Hardened Memory Characteristics, Radiation Hardness Assurance and Testing, Ferroelectric Random Access Memories (FRAMs), Gallium Arsenide (GaAs) FRAMs, Analog Memories, Magneto				

	Resistive Random Access Memories (MRAMs), Experimental Memory Devices. Memory Hybrids (2D & 3D), Memory Stacks, Memory Testing and Reliability Issues, Memory Cards, High Density Memory Packaging, Future Directions, Introduction to digital tablet PC, LCD, DVD player etc. **Texts:** 1. Ashok K.Sharma, " Semiconductor Memories Technology, Testing and Reliability ",Prentice- Hall of India Private Limited, New Delhi, 1997. 2. Memories", Springer Publication. 3. Wen C. Lin, "Handbook of Digital System Design", CRC Press.				
EC 539	MEMS and Microsystem Technology	3	0	0	6
Course Outcome	EC539.1: Ability to understand the operation of MEMS, micro systems and their applications. EC539.2: Ability to design the micro devices, micro systems using the MEMS fabrication process. EC539.3: Gain a knowledge of basic approaches for various sensor design. EC539.4: Gain a knowledge of basic approaches for various actuator design.				
	Historical Background: Silicon Pressure sensors, Micromachining, MicroElectro Mechanical Systems Microfabrication and Micromachining : Integrated Circuit Processes, Bulk Micromachining : Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA) Physical Microsensors : Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples : Thermal sensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors Microactuators : Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, microvalves, micropumps, micromotors-Microactuator systems : Success Stories, Ink-Jet printer heads, Micro-mirror TV Projector Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micromachined Systems : Success Stories, Micromotors, Gear trains, Mechanisms Application Areas:_ All-mechanical miniature devices, 3-D electromagnetic actuators and sensors, RF/Electronics devices, Optical/Photonic devices, Medical devices e g. DNA-chip, micro-arrays RF/Electronics device/system, Optical/Photonic device/system, Medical device e.g. DNA-chip, micro-arrays **Text/References:** 1. Stephen D. Senturia, "Microsystem Design" by, Kluwer Academic Publishers, 2001. 2. Marc Madou, "Fundamentals of Microfabrication" by, CRC Press, 1997.Gregory Kovacs, "Micromachined Transducers Sourcebook" WCB McGraw-Hill, Boston, 1998. 3. M.-H. Bao, "Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes" by Elsevier, New York, 2000.				
EC 540	Filter Design	3	0	0	6
Course Outcome	540.1: Learn and understand the basic parameters of signal and its processing methods. 540.2: Understand the concepts of different technique of signal processing based on various types of noise. 540.3: Understand the concept of various models to analyze the power spectrum. 540.4: Understand the concept of various Impulse noise modeling				
	Signals, Noise and Information, Signal Processing Methods, Transform-Based Signal Processing, Source-Filter Model-Based Signal Processing. Bayesian Statistical Model-Based Signal Processing. Different classes of noises and distortion, Linear prediction models, forward and backward models, Eigenvalue and PCA, power spectrum analysis. Impulse noise modelling, detection and removal, Impulse noise using linear prediction models.				

	Text/References: 1. S.V. Vaseghi, Advance signal processing and noise reduction, Wiley, 2008.				
EC 541	Biomedical Signal and Systems	3	0	0	6
Course Outcome	541.1 Understand the origin of biomedical signals and its dynamics 541.2 Learn the concept of pre-processing and filtering for removal of artifacts 541.3 Understand the methods for event detection and waveform analysis 541.4 Develop models for biomedical systems				
	Introduction to Biomedical Signals, Nature of Biomedical Signals, Examples of Biomedical Signals – EMG, ECG, EEG, ERPs, PCG, VMG, VAG, Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Concurrent, Coupled, and Correlated Processes- Illustration of the Problem with Case-Studies. Filtering for Removal of Artifacts- Illustration of the Problem with Case-Studies, Time-Domain Filters, Frequency-Domain Filters, Optimal Filtering, The Wiener Filter, Adaptive Filters for Removal of Interference, Selecting an Appropriate Filter Application: Removal of Artifacts in the ECG; Event Detection, Detection of Events and Waves, Correlation Analysis of EEG channels, Cross-spectral Techniques. The Matched Filter, Detection of the P Wave, Homomorphic Filtering, Application- ECG Rhythm Analysis, Identification of Heart Sounds, Wave shape and waveform Complexity, Analysis of Event-related Potentials, Morphological Analysis of ECG Waves, Envelope Extraction and Analysis of Activity, Application- Normal and Ectopic ECG Beats, Analysis of Exercise ECG. Frequency-domain Characterization The Fourier Spectrum, Estimation of the Power Spectral Density Function, Measures Derived form PSDs. Modeling Biomedical Systems, Point Processes Parametric System Modeling Autoregressive of All pole Modeling, Pole-Zero Modeling, Electromechanical Models of Signal Generation, Application- Heart-rate Variability, Spectral Modeling and Analysis of PCG. Analysis of Non stationary Signals, Time-Variant Systems, Fixed Segmentation, Adaptive Segmentation, Use of Adaptive Filters for Segmentation, Application- Adaptive Segmentation of EEG Signals, Adaptive Segmentation of PCG Signals. Pattern Classification and Diagnostic Decision , Pattern Classification, Supervised Pattern Classification, Unsupervised Pattern Classification, Probabilistic Models and Statistical Decision , Logistic regression Analysis The Training and Test Steps, Neural Networks, Measures of Diagnostic Accuracy and Cost, Reliability of Classifier and Decisions **Texts:** 1. R. M. Rangayyan "Biomedical Signal Analysis- A case study approach", Wiley Publications, 2006. 2. Eugene N Bruce "Biomedical signal processing and signal modeling", Wiley publications, 2007.				
EC 542	CPLD and FPGA Architecture	3	0	0	6
Course Outcome	542.1: Learn and understand the knowledge of PLDs, FPGA Design and architecture. 542.2: Understand the different types of arrays. 542.3: Design and analyze the FSM techniques and different case studies. 542.4: Design and implementation of various digital circuits using FPGA and its applications.				
	Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices –Architecture of Xilinx Cool Runner XCR3064XL CPLD, CPLD Implementation of a Parallel Adder with Accumulation. Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs. Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures. Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures, General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.				

	Text/References: 2. Field Programmable Gate Array Technology - Stephen M. Trimberger, Springer International Edition. 3. Digital Systems Design - Charles H. Roth Jr, Lizy Kurian John, Cengage Learning. 4. Field Programmable Gate Arrays - John V. Oldfield, Richard C. Dorf, Wiley India. 5. Digital Design Using Field Programmable Gate Arrays - Pak K. Chan/Samiha Mourad, Pearson Low Price Edition. 6. Digital Systems Design with FPGAs and CPLDs - Ian Grout, Elsevier, Newnes. 7. FPGA based System Design - Wayne Wolf, Prentice Hall Modern Semiconductor Design Series.

EC 551	Advance Digital Signal Processing	3	0	0	6
Course Outcome	551.1: Summarize various estimation methods in signal and image processing 551.2: Apply adaptive signal processing algorithms in various signal processing applications 551.3: Integrate FIR structures in multi-rate signal processing 551.4: Monitor various signals and systems in frequency domain using transforms				
	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 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. 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. Linear prediction and optimum linear filters: Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the Normal Equations, Levinson-Durbin Algorithm, Schiir Algorithm, Properties of the Linear Prediction-Error Filters, Wiener Filters for Filtering and Prediction Wavelet transforms :Fourier Transform : Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet. **Text/References:** 1. John G.Proakis, Dimitris G.Manobakis, Digital Signal Processing, Principles, Algorithms and Applications, Third edition, (2000) PHI 2. Monson H.Hayes – Statistical Digital Signal Processing and Modeling, Wiley, 2002. 3. L.R.Rabiner and R.W.Schaber, Digital Processing of Speech Signals, Pearson Education(1979). 4. Roberto Crist, Modern Digital Signal Processing, Thomson Brooks/Cole (2004) 5. Raghuveer. M. Rao, Ajit S.Bopardikar, Wavelet Transforms, Introduction to Theory and applications, Pearson Education, Asia, 2000				
EC 552	Information Theory and Coding	3	0	0	6
Course Outcome	552.1: Summarize various theorems related to information channels 552.2: Illustrate various encoding techniques related to information channels 552.3: Analyze informations using various encoding techniques 552.4: Monitor performance of encoding techniques in the application of data transmission				

	Definitions, Uniquely Decodable Codes, Instantaneous Codes, Krafts Inequality, McMillan's Inequality, Optimal Codes, Binary Huffman Codes, r-ary Huffman codes, Information and Entropy, Properties of Entropy Function, Entropy and Average Word-Length, Shannon-Fano Coding, Shannon's First Theorem, Information Channels, Binary Symmetric Channel, System Entropies, System Entropies for Binary Symmetric Channel, Extension of Shannon's First Theorem to Information Channels, Mutual Information, Mutual Information for the Binary Symmetric Channel, Hamming Distance, Shannon's Second (Fundamental) Theorem, Converse of Shannon's Theorems. Review: Algebra, Krawtchouk Polynomials, Combinatorial Theory, Probability Theory. Linear Codes: Block Codes, Linear Codes, Hamming Codes, Majority Logic Coding, Weight Enumerators, The Lee Metric, Hadamard Codes, Golay Codes (Binary and Ternary), Reed Muller Codes, And Kerdock Codes Bounds on Codes: Gilbert Bound, Upper Bound, Linear Programming Bounds, Hamming's Sphere –Packing Bound, Gilbert Varshamov Bound, Hadamard Matrices and Codes. Cyclic Codes: Generator Matrix, Check polynomial, Zeros of Cyclic Codes, BCH Codes, Reed-Solomon Codes, Quadratic Residue Codes, Generalized Reed-Muller Codes. Perfect Codes and Uniformly Packed Codes: Lloyd's Theorem, Characteristic Polynomial of a Code, Uniformly Packed Codes, Nonexistence Theorems. Quaternary Codes, Binary Codes Derived from codes over Z4, Galois Rings over Z4, Cyclic Codes over Z4. Goppa Codes. Algebraic Curves, Divisors, Differentials on a Curve, Riemann – Roch Theorem, Codes from Algebraic Curves. Arithmetic Codes: AN Codes, Mandelbaum – Barrows Codes, Convolutional Codes. **Text/References:** 1. G. A. Jones and J. M. Jones, "Information and Coding Theory", Springer, 2000. 2. J. H. van Lint, "Introduction to Coding Theory", Springer, 1999. 3. Cover Thomas, "Elements of Information Theory", and Wiley 2006. 4. R. W. Hamming, "Coding and Information Theory", Prentice Hall, 1986. 5. T. M. Cover and J. A. Thomas, "Elements of Information Theory", Wiley, 1991. 6. R. E. Blahut, "Principles and Practice of Information Theory," AWL, 1987.				
EC 553	Mobile Communication	3	0	0	6
Course Outcome	553.1: Familiarization with various cellular mobile systems technologies. 553.2: Concepts of cell coverage and antenna associated cellular communication. 553.3: Application of frequency reuse and channel assignments 553.4: Learning various multiple assess techniques and uncoming techniques.				
	Introduction to Cellular Mobile Systems: A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, planning a cellular system, overview of generations of cellular systems. Elements of Cellular Radio Systems Design and interference: General description of the problem, concept of frequency reuse channels, co-channel interference reduction factor, desired C/I from a normal case in an omni directional antenna system, cell splitting, consideration of the components of cellular systems. Introduction to co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects. Cell Coverage for Signal &. antenna structures: General introduction, obtaining the mobile point to point mode, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model-characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation. Characteristics of basic antenna structures, antenna at cell site, mobile antennas. Frequency Management & Channel Assignment, Hand Off & Dropped Calls: Frequency management,				

	fixed channel assignment, non- fixed channel assignment, traffic & channel assignment. Why hand off, types of handoff and their characteristics, dropped call rates & their evaluation. Modulation methods and coding for error detection and correction: Introduction to Digital modulation techniques, modulation methods in cellular wireless systems, OFDM. Block coding, convolution coding and Turbo coding. Multiple access techniques: FDMA, TDMA, CDMA; Time-division multiple access (TDMA), code division multiple access (CDMA), CDMA capacity, probability of bit error considerations, CDMA compared with TDMA Second generation, digital, wireless systems, GSM, IS_136 (D-AMPS), IS-95, mobile management, voice signal processing and coding. **Text/References:** 1. Mobile Cellular Telecommunications; 2nd ed.; William, C Y Lee McGraw Hill 2. Mobile wireless communications; Mischa Schwartz, Cambridge University press, UK, 2005 3. Mobile Communication Hand Book; 2nd Ed.; IEEE Press 4. Wireless communication principles and practice, 2nd Ed, Theodore S Rappaport, Pearson Education 5. 3G wireless Demystified; Lawrence Harte, Mc. Graw Hill pub				
EC 554	Data Communication	3	0	0	6
Course Outcome	EC554.1: Understand and explain Data Communications System and its components. EC554.2:Be familiar with the architecture of a number of different networks. EC554.3:Understand the principles of protocol layering. EC554.4: Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.				
	Concept of CCN/DCN, characteristics of data – Users' sub-network, topological design etc. Accessing techniques, Data Modeling – M/M/1 analysis, Circuit switching, message switching, Packet switching, and ATM cell switching, Protocols, ISO, OSI. Networking objectives, classification of networks – LAN, MAN, WAN, ISDN Techniques and theories of CSMA/CD Bus, Token Ring, Token passing bus- throughput analysis, Modeling (Stalling Models, IEEE Model etc.). Introduction to wireless networks, GSM, TDMA & CDMA-design and analysis, PCS concepts, Network operation and maintenance, NetworkDelay analysis, Routing, Flow Control, Congestion Control. **Text/Reference:** 1. Behrouz A. Forouzan, "TCP/IP Protocol Suit", TMH, 2000 2. Wayne Tomasi, "Introduction to Data communications and Networking", Pearson Ed 2007 3. Tananbaum A. S., "Computer Networks", 3rd Ed., PHI, 1999 4. Black U, "Computer Networks-Protocols, Standards and Interfaces", PHI, 1996 5. Stallings W., "Data and Computer Communications", 6th Ed., PHI, 2002. 6. Stallings W., "SNMP, SNMPv2, SNMPv3, RMON 1 & 2", 3rd Ed., Addison Wesley, 1999 7. Laurra Chappell (Ed), "Introduction to Cisco Router Configuration", Techmedia				
EC 556	Satellite Communication	3	0	0	6
Course Outcome	556.1 Understand the concept of orbital mechanics and launch methodologies 556 2 Understand how analog and digital technologies are used for satellite communication networks 556.3 Design link power budget for satellites 556.4 Understand the design of Earth station and tracking of the satellites.				
	Introduction: Origin and brief history of satellite communications, an overview of satellite system engineering, satellite frequency bands for communication. Orbital theory:Orbital				

	mechanics, locating the satellite in the orbit w.r.t. earth look angle determination. Azimuth & elevation calculations. Spacecraft systems: Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas. Satellite link design: Basic transmission theory, noise figure and noise temperature, C/N ratio, satellite down link design, satellite uplink design Modulation, Multiplexing, Multiple access Techniques: Analog telephone transmission, Fm theory, FM Detector theory, analog TV transmission, S/N ratio Calculation for satellite TV linking, Digital transmission, base band and band pass transmission of digital data, BPSK, QPSK , FDM, TDM, Access techniques: FDMA, TDMA, CDMA Encoding & FEC for Digital satellite links: Channel capacity, error detection coding, linear block, binary cyclic codes, and convolution codes. Satellite Systems: Satellite Earth station Technology, satellite mobile communication, VSAT technology, Direct Broadcast by satellite (DBS) **Text/Reference:** 1. Timothy Pratt, Charles W. Bostian, "Satellite communication", John Wiley & sons, Publication, 2003 2. J.J. Spilker, "Digital Communication by satellite, PHI Publication, 1997 3. J. Martin, "Communication satellite systems", PHI publication, 2001				
EC 557	Fiber Optics Communication	3	0	0	6
Course Outcome	557.1: Learning various Optical communication techniques. 557.2: Study of various types of Optical sources. 557.3: Study of various types of Photo detectors. 557.4: Learning techniques of optical amplification and optical couplers.				
	Overview of Optical Communications, Optical Fibers, Signal Degradation, International standards, Review of Optical Sources, Review of Photo detectors, structures for InGaAs APDs, Temperature effect on avalanche gain, Optical receiver, Introduction to optical amplifiers (EDFA), Overview of WDM, Passive optical couplers, Isolators and Circulators. **Texts:** 1. G.Keiser, Optical Fiber Communications, TMH, 4th Edition, 2008. 2. J. Gowar, Optical Communication Systems, PHI, 2nd Edition, 1993.				
EC 558	Advance Radio Communication	3	0	0	6
Course Outcome	558.1: To understand Modulators and Demodulators 558.2: To analyze TV and its mechanism 558.3: To understand Cameras. 558.4: To study Digital and satellite TV				
	Elements of a Communication Systems, FM Modulators, FET Phase Modulator, Foster-Seeley FM Discriminator, Ratio Detector, AM Transmitter, FM Transmitter, SSB Transmitter, TRF Radio Receiver, Super heterodyne Receiver, Image Frequency, AGC, SSB Transceiver, Special Features in Communication Receiver, Digital Radio, Television Broadcasting, TV Channels, TV Scanning, Indian TV Standards, composite video Signal, Functional blocks and operational aspects of each block of TV transmitter and receiver, CCD cameras, color TV display systems, Digital TV technology, HDTV systems. **Texts:** 1. Louis E Frenzil, Communication Electronics: Principles and Applications, 3rd Edition, MGH, 2001. 2. George Kennedy and Bernard Davis, Electronic Communication Systems, TMH, 4th Edition, 2000. 3. BernardGrob, Basic Television and Video Systems, 6th Edition, MGH, Singapore, 2000.				

EC 560	System-on-Chip (SoC)	3	0	0	6
Course Outcome	EC560.1: Design, optimize, and program a modern System-on-a-Chip. EC560.2: Implement both hardware and software solutions, formulate hardware/software tradeoffs, and perform hardware/software codesign. EC560.3: Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints. EC560.4: Appreciate issues in system-on-a-chip design associated with co-design, such as intellectual property, reuse, and verification.				
	IC Technology, Economics, CMOS Technology overview, Power consumption, Hierarchical design, Design Abstraction, EDA tools. MOSFET model, parasitics, latch up, advanced transistor structures; Wire parasitics; Design rules, Scalable design rules, process parameters; stick diagrams, Layout design tools; Layout synthesis, layout analysis. CMOS gate delays, transmission time, speed power product, low power gates; Delay by RC trees, cross talk, RLC delay, cell based layout, Logic & interconnect design, delay modeling, wire sizing; Power optimization, Switch logic networks. Pipelining, Data paths, Adders, ALUs, Multipliers, High density memories; Metastability, Multiphase clocking; Power optimization, Design validation, Sequential testing; Architecture for low power. Floor planning methods, global routing, switch box routing, clock distribution; off chip connections, packages, I/O architectures, pad design. Complete chip design including architecture, logic and layout for Kitchen timer chip OR Microwave oven chip. **Texts:** 1. Wayne Wolf, "Modern VLSI Design", Pearson Education, 1998. 2. Kamaran Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 2007 3. Rabey, Chandrakasan, "Digital IC Design", Preason Publication, 2009.				
EC 561	Software Defined Radio	3	0	0	6
Course Outcome	561.1: Understanding History of SDR. 561.2: To study the effective use of available frequency spectrum. 561.3: To enquire about the architectures of SDR. 561.4: To assimilate the future prospects of SDR.				
	SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication. Worldwide frequency band plans, Aim and requirements of the SCA, Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems, Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance, Radio Frequency design, Baseband Signal Processing, Radios with intelligence, Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future For Software Defined Radio **Texts/References:** 1. Dillinger, Madani, Alonistioti (Eds.): Software Defined Radio, Architectures, Systems and Functions, Wiley 2003 2. Reed: Software Radio, Pearson, 1997. 3. Software Defined Radio for 3G, 2002, by Paul Burns. 4.Tafazolli (Ed.): Technologies for the Wireless Future, Wiley 2005. 5. Bard, Kovarik: Software Defined Radio, The Software Communications Architecture, Wiley, 2007.				
EC 562	Microwave Devices and Circuits	3	0	0	6
Course Outcome	562.1: Gain knowledge and understanding of microwave analysis methods 562.2: Be able to apply analysis methods to determine circuit properties of passive/active microwave devices 562.3: Know how to model and determine the performance characteristics of a microwave circuit or system with or without using smith chart.				

	562.4: Have knowledge of basic communication link design, impedance matching and filter circuits.				
	Microwave frequencies, Interactions between electrons and fields, Electromagnetic plane waves, Electric and magnetic wave equations, Poynting theorem, Uniform plane waves and reflection, Plane wave propagation in free space and lossless dielectric, Plane wave propagation in lossy media, Plane wave propagation in metallic film coating on plastic substrate,Transmission line equations and solutions, Reflection coefficient and transmission coefficient, Standing wave and standing wave ratio, Line impedance and admittance, Smith chart, Microwave waveguides and components, Rectangular waveguides, Microwave cavities, Directional couplers, Circulators and isolators, Microwave transistors and tunnel diodes, Microwave bipolar transistors, Heterojunction transistors, Microwave tunnel diodes, Microwave field effect transistors, Junctionfield effect transistors, Metal semiconductor field effect transistors Text/References: 1. Samuel Y Liao, " Microwave Devices and Circuits" Third edition,PHI 2. SK Roy, M Mitra, "Microwave semiconductor devices", PHI 2003 3. David M. Pozar, "Microwave Engineering" Wiley				
EC 563	Advance Electromagnetic	3	0	0	6
Course Outcome	563.1: Understand the basic mathematical concepts related to electromagnetic vector fields. 563.2: Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density 563.3: Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density 563.4: Understand the concepts Maxwell's equations to solutions of problems relating to transmission lines and uniform plane wave propagation				
	Wave Equation, Waves in perfect dielectrics, Intrinsic wave constants, waves in lossy matter, reflection of waves, transmission line concepts, waveguide concepts, resonator concepts, radiation, and antenna concepts. Transmission line theory, Wave functions, Plane waves, rectangular waveguides, alternative mode sets, Rectangular cavity, partially filled wave guide, dielectric- slab guide, surface guided waves, modal Expansions of fields, currents in waveguides, Apertures in ground planes. **Text/References:** 1. R. F Harrington., "Time Harmonic Electromagnetics", McGraw Hill, 1961 2. RF Harrington, "Field Computation by Moment Methods", New York: MacMillan, 1968. 3. E.C Jordan & K.G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Edition, Prentice Hall India, Pvt. Ltd., New Delhi.				
EC 564	RF Component & Circuit Design	3	0	0	6
Course Outcome	EC564.1: Student should able to identify the basic RF devices. EC564.2: Student should able to understand the principle of the RF devices and systems. EC564.3: Student should able to realize the problems of RF system to solve it. EC564.4: Finally student should able to design the RF system for practical applications.				
	Transmission lines , Broadband Mactching, Scattering Parameters, microwave transistorsPassive Components: Inductors, Inductor Model, Analytical model, Printed Inductors, Inductors on Si substrate and GaAs substrate, Thick film inductors,Thin film inductors, LTCC inductors, Wire Inductors,Capacitors, Monolithic capacitors, interdigital capacitors, Resistors, chip resistor ,MCM resistor, Monolithic resistors, Microwave Resonators and Narrowband Filters, Broadband Filters Microwave Amplifier Design: Two-Port Power Gains, Amplifier Stability Low Noise Amplifier Design, Broadband Amplifier Design				

	Microwave Amplifier Design: Two-Port Power Gains, Amplifier Stability Low Noise Amplifier Design,Broadband Amplifier Design Microwave Oscillators: One Port negative resistance oscillators, Two Port negative resistance oscillators, Oscillator configurations **Text/References:** 1. Lumped Elements for RF and Microwave Circuits " I. J. Bahl ,Artech House 2. Microwave Transistor Amplifier: Analysis and Design, Gonzalez G. Prentice Hall 1984. 3. Microwave Semiconductor Circuit Design, Davis W. Alan, Van NostrandReinhold, 1984. 4. Microwave Circuit Analysis and Amplifier Design, Samuel Y. Liao, Prentice Hall 1987. 5. High Frequency Amplifier, Ralph S. Carson, Wiley Interscience, 1982				
EC 565	Antenna for Mobile Applications	3	0	0	6
Course Outcome	565.1: To impart knowledge about the fundamental concepts of antenna engineering. 565.2: To introduce the basic principle relevant to wired antennas and planar antennas 565.3: To enable the students to understand the factors related to frequency, radiation pattern and interference 565.4: Understanding the Practical antennas for various mobile application.				
	Radiation fields of wire antennas: Concept of vector potential. Modification for time varying retarded case. Fields associated with Hertzian dipole. Radiation resistance of elementary dipole with linear current distribution. Radiation from half-wave dipole and quarter – wave monopole. Use of capacity hat and loading coil for short antennas. Antenna Fundamentals and Antenna Arrays: Definitions: Radiation intensity, Directives gain, Directivity, Power gain, Beam Width, Band Width, Gain and radiation resistance of current element. Half-wave dipole and folded dipole. Reciprocity principle, Effective length and Effective area. Relation between gain effective length and radiation resistance. Loop Antennas: Radiation from small loop and its radiation resistance. Antenna Arrays: Expression for electric field from two and three element arrays. Uniform linear array. Method of pattern multiplication. Binomial array. Use of method of images for antennas above ground. Traveling wave (wideband) antennas: Radiation from a traveling wave on a wire. Analysis and design of Rhombic antenna. Coupled Antennas: Self and mutual impedance of antennas. Two and Three element Yagi antennas, Log periodic antenna. Aperture and Lens Antennas: Radiation from an elemental area of a plane wave (Huygen's Source). Radiation from the open end of a coaxial line. Radiation from a rectangular aperture treated as an array of Huygen's sources. Relation between dipole and slot impedances. Method of feeding slot antennas. **Text/References:** 1. E.C. Jordan and Balmain, "Electro Magnetic Waves and Radiating Systems", PHI, 1968, Reprint 2003 2. John D. Kraus and Ronalatory Marhefka, "Antennas", Tata McGraw-Hill Book Company, 2002 3. R.E. Collins, "antennas and Radio Propagation", McGraw-Hill, 1987 4. Ballany, "Antenna Theory", John Wiley & Sons, Second Edition, 2003				
EC 567	Electromagnetic Interference	3	0	0	6
Course Outcome	567.1: To familiarize with the fundamentals that are essential for electronics industry in the field of EMI / EMC. 567.2: To understand EMI sources and its measurements. 567.3: Concept of signal integrity in ICs, conducted emissions and electromagnetic radiation susceptibility, and crosstalk and shielding 567.4: To understand the various techniques for electromagnetic compatibility.				
	Introduction to Electromagnetic Compatibility (EMC), EMC Requirements for Electronic Systems, Radiated Emissions, Conducted Emissions ,Spectra of Digital				

	Waveforms, The Spectrum of Trapezoidal (Clock) Waveforms, spectral Bounds for Trapezoidal Waveforms, Effect of Rise/Fall-time on Spectral Content, Bandwidth of Digital Waveforms, Effect of Repetition Rate and Duty Cycle, Effect of Ringing (Undershoot/Overshoot) Transmission Lines and Signal Integrity: The Transmission-Line Equations, Printed Circuit Board (PCB) Structures, High-Speed Digital Interconnects and Signal Integrity Sinusoidal Excitation of the Line and the Phasor Solution. Conducted Emissions and Susceptibility: Measurement of Conducted Emissions,I The Line Impedance Stabilization Network (LISN),Common- and Differential-Mode Currents Again, Power Supply Filters, Basic Properties of Filters, A Generic Power Supply Filter Topology, Effect of Filter Elements on Common. Differential-Mode Currents, Separation of Conducted Emissions into Common and Differential-Mode Components for Diagnostic Purposes, Power Supplies, Linear Power Supplies, Switched-Mode Power Supplies (SMPS), Effect of Power Supply Components on Conducted Emissions, Power Supply and Filter Placement, Conducted Susceptibility **Text/References:** 1. Clayton R Paul: Introduction to Electromagnetic Compatibility Wiley 2nd Edition 2. V.P. Kodali, "Engineering Electromagnetic Compatibility",S. Chand & Co. Ltd., New Delhi, 2000. 3. "Electromagnetic Interference and Compatibility", IMPACT series, IIT-Delhi, Modules1-9. 4. Keiser, "Principles of Electromagnetic Compatibility", 3rd ed., , Artech House 5. Henry W.Ott.,"Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988				
EC 568	Radar Engineering	3	0	0	6
Course Outcome	EC568.1: Student should able to identify different type of radar technology. EC568.2: Student should able to realize the difference between radar and any other communication systems. EC568.3: Student should able to understand how the radar is used in communication system. EC568.4: Student should able to design the radar system.				
	Radar and Radar Equation, Doppler Effect, CW Radar, FM - CW radar, altimeter, Multiple Frequency Radar, Pulse Radar, Pulse Doppler Radar, Tracking Radar, RADAR System Design, Matched Filter, Detector Characteristics, Phased Arrays, Advantages and Limitations Navigational Aids. **Text/References:** 1. M.I. Skolnik, Introduction Radar Systems, McGraw Hill Book Co., Fourth Edition, 2001. 2. G.S.N. Raju, Radar Engineering and Fundamentals and Navigational Aids, I.K. International, 2008. 3. Simon Kingsley and Shaun Quegan, Understanding Radar Systems, SciTech Publishing, 1999. 4. Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, 2007.				
EC 569	Advanced Antenna Technology	3	0	0	6
Course Outcome	569.1: Identify basic antenna parameters and list the different types of antenna 569.2: solve the radiation mechanism of linear antennas 569.3: Compare the different types of antennas and classify their uses. 569.4: Design a microstrip antenna and analyse the results.				

	Basic of the Antenna, Different radiation zones, Mechanism of radiation, Scattering parameters, dipole antennas and arrays, horn antenna, slot antenna, SIW antenna, dielectric resonator antenna, Helical antenna, Log periodic antenna, Microstrip antenna design: structure, feeding techniques, field distribution, surface wave propagation, radiation mechanism, microstrip array antenna. **Text/References:** 1. C. A. Balanis, "Antenna Theory: Analysis and Design," John Wiley & Sons, 2009. 2. R. J. Marhefka, A. S. Khan and J. D. Kraus, "Antennas and Wave Propagation", Tata McGraw - Hill Education 2010. 3. M. Sachidananda and A R. Harish "Antennas and Wave Propagation" Oxford University Press, USA 2007.				
EC 570	Advance EM Wave Propagation and Antenna	3	0	0	6
Course Outcome	EC570.1: Identify basic wireless propagation system using various antennas. EC570.2: Student should able to solve the problem of radiation interferences. EC570.3: Student should able to characterize the EM wave. EC570.4: Design a microstrip antenna for given frequency band and analyse the results.				
	Review of Maxwell's Equation and boundary conditions; time harmonic electromagnetic fields; vector potentials; electromagnetic theorems and concepts, Impedance matching and tuning, dipole antennas and arrays, horn antennas, parabolic antennas, slot antennas and arrays, microstrip antennas, Ground wave propagation, sky wave propagation, space wave propagation. **Texts / References:** 1. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 2009. 2. R. F. Harrington, "Time Harmonic Electromagnetic Fields," McGraw Hill, 2001. 3. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 1989. 4. R. E. Collin, "Antenna and radio wave propagation," McGraw Hills, 1985. 5. C. A. Balanis, "Antenna Theory: Analysis and Design," John Wiley & Sons, 2009. 6. R. J. Marhefka, A. S. Khan and J. D. Kraus, "Antennas and Wave Propagation", Tata McGraw - Hill Education 2010. 7. M. Sachidananda and A. R. Harish "Antennas and Wave Propagation" Oxford University Press, USA 2007.				
EC 571	Principle of Microwave solid state devices	3	0	0	6
Course Outcome	EC571.1: Explain different types of microwave devices. EC571.2: Describe and explain working of microwave tubes and solid state devices. EC571.3: Study of different microwave diode based devices. EC571.4: Traveling wave tube and Reflex klystron working and its application.				
	Microwave devices and applications, Transferred electron devices, Gunn – effect diodes – GaAs diode, Ridley- watkins-Hilsum (RWH) theory, Modes of operation, LSA diodes, InP diodes, Avalanche transit time devices, Read diode, IMPATT diode, TRAPATT diodes, BARITT diodes, Microwave linear beam tubes (O Type), Conventional vacuum triodes, Tetrodes and pentodes, klystrons, Multicavity klystron amplifiers, Reflex klystrons, Helix traveling wave tubes (TWT), Coupled cavity traveling wave tubes, Microwave crossed filed tubes (M Type), Magnetron oscillators, Forward wave crossed field amplifier (FWCFA OR CFA), Strip lines, Microstrip lines, Parallel strip lines, Coplanar strip lines, Shielded strip lines, Monolithic microwave integrated circuits, Materials, Monolithic microwave integrated circuit growth, MOSFET fabrication. **Text/References:** 1. Samuel Y.Liao, " Microwave Devices and Circuits" Third edition,PHI 2. SK Roy, M Mitra, "Microwave semiconductor devices", PHI 2003 3. David M. Pozar, "Microwave Engineering" Wiley				

EC 572	Microwave Filter Design	3	0	0	6
Course Outcome	EC572.1: Identify basic filter parameters and list the different types of techniques. EC572.2: Student should able to design low pass, high pass, band pass and band stop filter. EC572.3: Student should able to differentiate basic characteristics of the filters. EC572.4: Student should able to implement the FSS for varies application in communication system.				
	Introduction, General procedure for filter design, Active and passive filters, Periodic Structures, Filter Design by the Image Parameter Method, Filter Transformations, Insertion Loss Methode, Type of Low Pass Filter, Maximally Flat, Butterworth, Binomial Filter, Equal Ripple or Chebyshev Filter, Elliptic Filter, Linear Phase Filter, Types of Scaling for Low Pass Prototype, Filters implementation in microwave circuits, Stepped Impedance Low Pass Filters, Filter Implementation, Stepped-Impedance Low-Pass Filters, Coupled Line Filters, Filters Using Coupled Resonators. **Text/References:** 1. Devid M. Pozer, " Microwave Engineering" 4th edition, Wiley. 2. Samuel Y.Liao, " Microwave Devices and Circuits" Third edition,PHI 3. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 2009.				
EC 574	Image Processing Techniques	3	0	0	6
Course Outcome	574.1: Illustrate various transform methods in image processing 574.2: Apply various filtering techniques for image enhancement and image restoration 574.3: Analyze various image segmentation algorithms 574.4: Evaluate transforms (DCT,FFT etc) and encoding techniques in application of image compression				
	Two-dimensional mathematical preliminaries, 2D transforms – DFT, DCT, KLT, SVD. Image Enhancement - Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement. Image restoration - Degradation model, Unconstrained restoration - Lagrange multiplier and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations-spatial transformations, Image segmentation - Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm-Segmentation by K-Means Algorithm. Digit Recognition using Convolutional Neural network. Compression - Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Image Morphology - Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms. **Texts/ References:** 1. Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, Second Edition, Pearson Education/PHI, 2000. 2. W.K.Pratt, Digital Image Processing , 3/e Edn , John Wiley & sons, Inc. 2006. 3. K. R. Castleman, Digital Image Processing, Pearson, 2006. 4. Anil K. Jain, Fundamental of image processing, Pearson, 2002. 5. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning, 2008. 6. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology, 2004. 7. Computer Vision and Image Processing, Adrian Low, Second Edition, B.S. Publications, 2005. 8. Digital Image Processing using Matlab, Rafael C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education, 2007.				

EC 576	Research Methodology for Engineers	3	0	0	6

Course Outcome
576.1: To understand research problems and planning.
576.2: To familiarize with various research resources and academic writing.
576.3: Understanding data collection, analysis and result presentation.
576.4: To study mathematical modeling.

Research Preparation and Planning: Objectives of research - research and its goals. Critical thinking. Techniques for generating research topics. Topic selection and justification. Development of a research proposal – Theoretical and Experimental Processes.

Research Resources: Sources of information. Literature search. World Wide Web. Online data bases – search tools. Citation indices - Principles underlying impact factor – literature review – Case studies, review articles and Meta-analysis – record of research review - Role of the librarian. Ethical and Moral Issues in Research. Plagiarism, tools to avoid plagiarism – Intellectual Property Rights – Copy right laws – Patent rights.

Academic Writing and Presentation: Proposal submission for funding agencies. Elements of Style. Organization of proposals. Basic knowledge of funding agencies. Research report writing. Communication skills. Tailoring the presentation to the target audience – Oral presentations. Poster preparations. Submission of research articles for Publication to Reputed journals. Thesis writing, and Research report writing. Elements of excellent presentation: Preparation, Visual and Delivery. Oral Communication skills and Oral defense.

Data Collection, Analysis and Inference: Basic Statistical Distributions and their applications - Binomial, Poisson, Normal, Exponential, Weibull and Geometric Distributions. Sample size determination & sampling Techniques-Random sampling, stratified sampling, systematic sampling and cluster sampling. Large Sample Tests and Small Sample Tests-Student-t-test, F-test and χ^2 test and their applications in research studies. Correlation and Regression Analysis-Time series Analysis-Forecasting methods. Factor analysis, Cluster Analysis and Discriminant Analysis. Principles of Experimentation. Basic Experimental Designs: Completely Randomized Design Randomized Block Design and Latin Square Design. Factorial Designs: 2^2, 2^3 and 2^4 – Accuracy, Precision and error analysis.

Mathematical Modelling: Basic concepts of modeling of Engineering systems – static and dynamic model – Model for prediction and its limitations. System simulation – validation. Use of optimization techniques – Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization.

Texts/ References:

1. Research Methodology for Engineers. Ganesan R. MJP Publishers, Chennai.
2. Probability & Statistics for Engineers and Scientists. Walpole R. V., Myers R.H., Myers S.L. and Ye. King: Pearson Prentice Hall, Pearson Education.
3. Thesis and assignment writing. Anderson R.H., Dursaton, and Poyre M., Wiley Eastern.
4. How to write and illustrate scientific papers?. Bijoen Gustavii, Cambridge University Press.
5. Research Design and Methods. Bordens K.S. and Abbott. B.b.: M. Graw Hill.