Graphic Era Deemed to be University DEHRADUN

NAAC GRADE A+ ACCREDITED

CURRICULUM
for
UNDERGRADUATE DEGREE PROGRAM

BACHELOR OF TECHNOLOGY
IN
Electronics and Communication Engineering
Scheme of Teaching and Evaluation 2024
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2024-25)
(For Batch 2024-2028 & Batch 2023-2027 3rd Semester onwards)

In accordance with NEP 2020 and AICTE Model Curriculum

GRAPHIC ERA (DEEMED TO BE UNIVERSITY)
566/6, Bell Road, Clement Town,
Dehradun, Uttarakhand 248002 INDIA
https://www.geu.ac.in

8. Program Structure

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Nomenclature as per AICTE

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Electives Courses
LC	Laboratory courses
MC	Mandatory Non-Credit Courses
PROJ	Project/Seminar/Internship/Summer training

C. Nomenclature as per NEP 2020

Code	Definitions
DSC	Discipline Specific Courses
DSE	Discipline Specific Elective
UOE	University Open Elective
AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
PROJ	Project/Seminar/Internship/Summer training
VAC	Value Added Courses
MNG	Mandatory Non-Graded Courses

Definitions

Courses of study – Courses of study indicates pursuance of study in a particular discipline. Every discipline shall offer various categories of courses of study, viz. Discipline Specific Courses (DSC), Discipline Specific Electives (DSE), University Open Elective (UOE) / Generic Elective (GE), Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC), Value Added Courses (VAC), Internship/Apprenticeship/Project/Community Outreach (PROJ) and Mandatory Non-Graded Course (MNG)

a) Discipline Specific Courses (DSC): Discipline Specific Courses is a course of study, which should be pursued by a student as a major component, of the discipline as mandatory requirement of his/her programme of study. DSC shall be the core credit courses of that particular discipline which will be appropriately graded and arranged across the semesters of study.

b) Discipline Specific Elective (DSE): The Discipline Specific Electives (DSE) shall be a pool of credit courses of that particular discipline (single discipline programme of study) or those disciplines (multidisciplinary programme of study), as the case may be, which a student chooses to study from his/her particular discipline(s). There shall be a pool of DSE from which a student may choose a course of study.

c) University Open Elective/Generic Elective (UOE/GE): An elective course chosen generally from other discipline(s) with an intention to seek exposure is called a University Open Elective/Generic Elective. UOE shall consist of a pool of courses offered by various disciplines of study in groups of odd and even semesters, from which a student can choose.

d) Ability Enhancement Courses (AEC): Ability Enhancement courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

e) Skill Enhancement Courses (SEC): SE courses are skill-based courses in all disciplines and are aimed at providing hands-on-training, skills.

f) Value Addition Course (VAC): VA courses are value-based courses which are meant to inculcate ethics, culture, Indian Knowledge systems, constitutional values, soft skills, sports education and such similar values to students which will help in all round development of students.

g) Major Project/Seminar/Internship/Summer training (PROJ):

i. Internship /Apprenticeship: All students will also undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions.

ii. Major Project: Students are required to take up major project under the guidance of a faculty member. The student shall be encouraged to get engaged in Research Based Project in final year (VII and VIII semesters). The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.

h) Mandatory Non-Graded Courses (MNG)

These courses are offered to nurture holistic qualities in a student, making him/her a responsible citizen conscious of societal & global challenges and responsibilities thereof. These include Indian Knowledge System (IKS), Healthy Living and Fitness, Environmental Sciences, Indian Constitution and so on. Generally, shall be offered through hybrid mode with mentors and shall be **evaluated through End Semester examination**.

9. Major Features of Curriculum

- Flexible Choice Based System for students to pursue courses of their interest.
- Includes Range of Courses to cover up the diversity of Electronics and Communication Engineering Specializations.
- High Practical approach through Project work and emerging technologies in VLSI and Wireless Communication courses in which students will visit the reputed research organizations and / or industries and perform real time project.
- To impart high competency in the students, the curriculum offers distinct ability enhancement and value-added courses.
- Apart from the technical course, the program offers a range of courses that provides the students a broad range of knowledge and skill set like life skills and mentoring, soft skills, Aptitude, Communication skills, social and professional ethics in engineering, environmental engineering, and management.
- The curriculum offers multi-disciplinary courses running in the university for other filed/areas.

Course Components of Academic Program
B.Tech (Electronics and Communication Engineering)

Program Duration : 8 Semesters (4 Years)

S.No.	AICTE Course Components	Breakup of Credits B.Tech ECE	Breakup of Credits B.Tech ECE-ESR	Breakup of Credits B.Tech ECE-IoT
1	Humanities and Social Sciences including Management courses (HSMC)	20	20	20
2	Basic Science Courses (BSC)	15	15	15
3	Engineering Science courses including workshop, drawing, basics of electronics/electrical/mechanical/computer etc. (ESC)	11	11	11
4	Professional Core Courses (PCC)	54	72	72
5	Laboratory course(LC)	25	25	25
6	Open Elective Courses (OEC)	6	6	6
7	Professional Elective Courses (PEC)	21	21	21
8	Project work, seminar and internship in industry or elsewhere (PROJ)	14	14	14
	Total Credits	**166**	**184****	**184****

9	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition, Healthy Living and Fitness] (MC)	8	8	8

****Optional Additional Credits to earn Specialization (Honours): 18 Credits**

S. No.	NEP Course Components	Breakup of Credits B.Tech ECE	Breakup of Credits B.Tech ECE-ESR	Breakup of Credits B.Tech ECE-IoT
1	Discipline Specific Courses (DSC)	100	118	118
2	Discipline Specific Elective (DSE)	21	21	21
3	University Open Elective ((UOE)/Generic Elective (GE)	6	6	6
4	Ability Enhancement Courses (AEC)	8	8	8
5	Value Added Courses (VAC)	3	3	3
6	Skill Enhancement Courses (SEC)	14	14	14
7	Project/Seminar/Internship/Summer training (PROJ)	14	14	14
	Total Credits	**166**	**184****	**184****

8	Mandatory Non-Graded Courses (MNG)	8	8	8

****Optional Additional Credits to earn Specialization (Honours): 18 Credits**

10. Scheme

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester I

COURSE MODULE Physics/ Chemistry Group					**TEACHING PERIODS**				**WEIGHTAGE : EVALUATION**			
COURSE				**Credits**	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
Code	**Title**	**NEP Component**	**AICTE Component**									
THU101	Professional Communication	AEC	HSMC	2	2	0	0	2	25	25	50	100
TPH101/201	Engineering Physics	DSC	BSC	3	3	0	0	3	25	25	50	100
TMA101	Engineering Mathematics-I	DSC	BSC	3	2	1	0	3	25	25	50	100
TEE101/201	Basic Electrical Engineering	DSC	ESC	2	2	0	0	2	25	25	50	100
TCS101	Fundamental of Computer & Introduction to Programming	DSC	ESC	3	3	0	0	3	25	25	50	100
HSMC 101/201	Design Thinking	VAC	ESC	1	0	0	2	2	25	25	50	100
PEE151/251	Electrical Engineering Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PPH151/251	Physics Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PME151/251	Workshop And Manufacturing Practices	SEC	LC	2	0	0	4	4	25	25	50	100
PCS151	Computer Lab-I	DSC	LC	2	0	0	4	4	25	25	50	100
			Total	**20**	**12**	**1**	**14**	**27**	**250**	**250**	**500**	**1000**
MNG Course												
THF101/201	Healthy Living & Fitness	MNG	MC	2	2	0	0	***Qualified/ Not Qualified***				

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester II

COURSE MODULE Physics/ Chemistry Group					**TEACHING PERIODS**				**WEIGHTAGE : EVALUATION**			
COURSE				**Credits**	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
Code	**Title**	**NEP Component**	**AICTE Component**									
THU201	Advanced Professional Communication	AEC	HSMC	2	2	0	0	2	25	25	50	100
TCH101/ 201	Engineering Chemistry	DSC	BSC	3	3	0	0	3	25	25	50	100
TMA201	Engineering Mathematics-II	DSC	BSC	3	2	1	0	3	25	25	50	100
TCS201	Programming for problem solving	DSC	ESC	3	3	0	0	3	25	25	50	100
TEC101/ 201	Basic Electronics Engineering	DSC	ESC	2	2	0	0	2	25	25	50	100
PCH151/ 251	Chemistry Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PME153/ 253	Engineering Graphics and Design Lab	SEC	LC	2	0	0	4	4	25	25	50	100
PCS251	Computer Lab - II	DSC	LC	2	0	0	4	4	25	25	50	100
PEC151/ 251	Basic Electronics Engineering Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PCE151/ 251	Basic Civil Engg Lab	DSC	LC	1	0	0	2	2	25	25	50	100
GP201	General Proficiency-I	AEC	HSMC	1	-	-	-	-	100	-	-	100
			Total	**21**	**12**	**1**	**14**	**27**	**350**	**250**	**500**	**1100**
MNG Course												
TEV101/ 201	Environmental Science	MNG	MC	2	2	0	0	2	***Qualified/ Not Qualified***			

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester III

COURSE MODULE					TEACHING PERIODS				WEIGHTAGE: EVALUATION			
COURSE				Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
Code	Title	NEP Component	AICTE Component									
TEC 301	Electronic Devices and Circuits	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 302	Digital Electronics	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 303	Networks Analysis and Synthesis	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 304	Signals and Systems	DSC	PCC	3	3	0	0	3	25	25	50	100
UHV 301	Universal Human Value - II	VAC	HSMC	2	2	0	0	2	25	25	50	100
TMA 310	Advanced Engineering Mathematics	DSC	BSC	3	3	0	0	3	25	25	50	100
TEC 34X	Discipline Specific Elective-I	DSE	PEC	3	3	0	0	3	25	25	50	100
XCS301	Career Skills	SEC	HSMC	2	2	0	0	2	25	25	50	100
PEC 301	Electronics Circuit Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 302	Digital Electronics Lab	DSC	LC	1	0	0	2	2	25	25	50	100
			Total	**24**	**22**	**0**	**4**	**26**	**250**	**250**	**500**	**1000**

Optional

		TEACHING PERIODS				WEIGHTAGE: EVALUATION			
	Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
**Minor-I/Specialization-I	3	3	0	0	3	25	25	50	100

** *List of minor/ specialization courses is mentioned on page no.32*

Discipline Specific Elective-I

Course Code	Course Name
TEC 341	Electronic Instrumentation
TEC 342	Foundations of Artificial Intelligence
TEC 343	Electronics Engineering Materials
TEC 344	Linear Algebra (Through Swayam)

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester IV

COURSE MODULE					**TEACHING PERIODS**				**WEIGHTAGE: EVALUATION**			
COURSE				**Credits**	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
Code	**Title**	**NEP Component**	**AICTE Component**									
TEC 401	Communication Systems I	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 402	Analog Integrated Circuits	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 403	Microprocessor and its Applications	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 404	Electromagnetic Field Theory	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 44X	Discipline Specific Elective-II	DSE	PEC	3	3	0	0	3	25	25	50	100
TEC 405	Data Structures with C	DSC	PCC	3	3	0	0	3	25	25	50	100
XCS 401	Career Skills	SEC	HSMC	2	2	0	0	2	25	25	50	100
PEC 401	Communication Systems I Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 402	Analog Integrated Circuits Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 403	Microprocessor Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 404	Mini Project-I	PROJ	PROJ	1	0	0	2	2	25	25	50	100
PEC 405	Data Structures Lab	DSC	LC	1	0	0	2	2	25	25	50	100
GP 401	General Proficiency-II	AEC	HSMC	1	0	0	-	-	100	-	-	100
Total				**26**	**20**	**0**	**10**	**30**	**400**	**300**	**600**	**1300**
MNG Course												
HSS203	Constitution of India	MNG	MC	2	2	0	0	***Qualified/ Not Qualified***				

Optional									
		TEACHING PERIODS				**WEIGHTAGE: EVALUATION**			
	Credits	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
**Minor-II/Specialization-II	3	3	0	0	3	25	25	50	100
** *List of minor/ specialization courses is mentioned on page no.32*									

Discipline Specific Elective-II

Course Code	Course Name
TEC 441	Semiconductor Devices and Technology
TEC 442	Basics of Nanotechnology
TEC 443	Introduction to Machine Learning (Through Swayam)
TEC 444	Analog IC Design (Through Swayam)

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester V

COURSE MODULE					TEACHING PERIODS				WEIGHTAGE: EVALUATION			
COURSE				Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
Code	Title	NEP Component	AICTE Component									
TEC 501	Digital Signal Processing	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 502	Communication Systems II	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 503	Microcontroller and Embedded Systems	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 504	Antenna and Wave Propagation	DSC	PCC	3	3	0	0	3	25	25	50	100
XCS-501	Career Skills	SEC	HSMC	2	2	0	0	2	25	25	50	100
TEC 54X	Discipline Specific Elective-III	DSE	PEC	3	3	0	0	3	25	25	50	100
PEC 501	Digital Signal Processing Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 502	Communication Systems II Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 503	Microcontroller & Embedded Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 504	Mini Project-II	PROJ	PROJ	1	0	0	2	2	25	25	50	100
			Total	**21**	**17**	**0**	**08**	**25**	**250**	**250**	**500**	**1000**
MNG Course												
HSS304	Indian knowledge System	MNG	MC	2	2	0	0	2	***Qualified/ Not Qualified***			

Optional									
		TEACHING PERIODS			**WEIGHTAGE: EVALUATION**				
	Credits	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
**Minor-III/Specialization-III	3	3	0	0	3	25	25	50	100
** *List of minor/ specialization courses is mentioned on page no. 32*									

Discipline Specific Elective-III

Course Code	Course Name
TEC 541	Control Systems (Through Swayam)
TEC 542	Electromagnetic Interference and Compatibility
TEC 543	High Speed Communication Circuits
TEC 544	Introduction To Probability Theory And Stochastic Processes (Through Swayam)
TEC 545	Deep Learning (Through Swayam)

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester VI

COURSE MODULE					TEACHING PERIODS				WEIGHTAGE: EVALUATION			
COURSE				Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
Code	Title	NEP Component	AICTE Component									
TEC 601	Wireless Communication	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 602	Microwave Engineering	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 603	VLSI Technology and Design	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 604	Object Oriented Programming with C++	DSC	PCC	3	3	0	0	3	25	25	50	100
XCS 601	Career Skills	SEC	HSMC	2	2	0	0	2	25	25	50	100
TEC 64X	Discipline Specific Elective-IV	DSE	PEC	3	3	0	0	3	25	25	50	100
PEC 601	CAD of Electronics Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 602	Microwave and Antenna Lab	DSC	LC	1	0	0	2	2	25	25	50	100
PEC 603	Mini Project-III	PROJ	PROJ	1	0	0	2	2	25	25	50	100
PEC 604	OOPs with C++ Lab	DSC	LC	1	0	0	2	2	25	25	50	100
GP 601	General Proficiency-III	AEC	HSMC	1	0	0	0	-	100	-	-	100
			Total	**22**	**17**	**0**	**8**	**25**	**350**	**250**	**500**	**1100**

Optional									
		TEACHING PERIODS				**WEIGHTAGE: EVALUATION**			
	Credits	**L**	**T**	**P**	**Contact Hr.**	**CIE**	**MSE**	**ESE**	**Total**
**Minor-IV/Specialization-IV	3	3	0	0	3	25	25	50	100
** *List of minor/ specialization courses is mentioned on page no.32*									

Discipline Specific Elective-IV

Course Code	*Course Name*
TEC 641	*Data Communication Networks*
TEC 642	*Digital VLSI Circuit Design*
TEC 643	*Digital Video Processing*
TEC 644	*Fuzzy Sets, Logic and Systems & Applications (Through Swayam)*
TEC 645	*Multirate DSP (Through Swayam)*

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester VII

COURSE MODULE					TEACHING PERIODS				WEIGHTAGE: EVALUATION			
COURSE				Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
Code	Title	NEP Component	AICTE Component									
TEC 701	Computer Architecture	DSC	PCC	3	3	0	0	3	25	25	50	100
TEC 74X/75X	Discipline Specific Elective-V	DSE	PEC	3	3	0	0	3	25	25	50	100
	University Open Elelctive /Generic Elective I	UOE/GE	OEC	3	3	0	0	3	25	25	50	100
SEC 701	Seminar on Industrial Training	PROJ	PROJ	1	0	0	2	2	-	-	100	100
PEC 701	Project Phase I	PROJ	PROJ	4	0	0	8	8	50	-	50	100
			Total	**14**	**9**	**0**	**10**	**19**	**125**	**75**	**300**	**500**

Optional

		TEACHING PERIODS				WEIGHTAGE: EVALUATION			
	Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
**Minor-V/Specialization-V	3	3	0	0	3	25	25	50	100

** *List of minor/ specialization courses is mentioned on page no.32*

Discipline Specific Elective V

Course Code	***Course Name***
TEC 741	*Mobile Ad hoc Networks*
TEC 742	*Electronics System Design*
TEC 743	*Design of Analog CMOS Circuit*
TEC 744	*Speech Processing*
TEC 745	*Phase-Locked Loops (Through Swayam)*
TEC 746	*Digital Image Processing (Through Swayam)*
TEC 747	*Optical Fiber Communications*
TEC 748	*ASIC and FPGA Design*
TEC 749	*Radar and Navigation Aids*
TEC 750	*Organic Electronics*
TEC 751	*Computer Vision (Through Swayam)*
TEC 752	*VLSI Design Flow: RTL to GDS (Through Swayam)*

Graphic Era (Deemed to be University)

B.Tech. in Electronics and Communication Engineering

Scheme of Teaching and Evaluation 2024

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) as per NEP 2020 and AICTE Model Curriculum

(Effective from the academic year 2024-25)

Semester VIII

COURSE MODULE					TEACHING PERIODS				WEIGHTAGE: EVALUATION			
COURSE				Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
Code	Title	NEP Component	AICTE Component									
TEC 84X	Discipline Specific Elective-VI	DSE	PEC	3	3	0	0	3	25	25	50	100
TEC 85X	Discipline Specific Elective-VII	DSE	PEC	3	3	0	0	3	25	25	50	100
DM001	Disaster Management	SEC	HSMC	2	2	0	0	2	25	25	50	100
	University Open Elelctive /Generic Elective I	UOE/GE	OEC	3	3	0	0	3	25	25	50	100
PEC 801	Project Phase-II	PROJ	PROJ	6	0	0	12	12	-	-	100	100
GP 801	General Proficiency-IV	AEC	HSMC	1	0	0	0		100	-	-	100
			Total	**18**	**11**	**0**	**12**	**23**	**200**	**100**	**300**	**600**

Optional

		TEACHING PERIODS				WEIGHTAGE: EVALUATION			
	Credits	L	T	P	Contact Hr.	CIE	MSE	ESE	Total
**Minor-VI/Specialization-VI	3	3	0	0	3	25	25	50	100

** *List of minor/ specialization courses is mentioned on page no.32*

Discipline Specific Elective

Course Code	***Course Name***	***Discipline Specific Elective***
TEC 841	*Satellite Communications*	*VI*
TEC 842	*Testing of VLSI circuits*	
TEC 843	*Digital System using VHDL*	
TEC 844	*Cognitive Radio*	
TEC 845	*Biomedical Signal Processing (Through Swayam)*	
TEC 846	*Digital IC Design (Through Swayam)*	
TEC 851	*Telecommunication Switching*	*VII*
TEC 852	*Optimization Methods in Machine Learning*	
TEC 853	*Wireless Sensor Networks*	
TEC 854	*Adaptive Signal Processing*	
TEC 855	*Spread Spectrum Communications and Jamming (Through Swayam)*	
TEC 856	*Sensors and Actuators (Through Swayam)*	

NOTE: General Proficiency shall be assessed based on the participation in NCC, NSS, Research paper Publication (Journal/ Conference), Organizing events, competitions (Inter University, State, National, International level) including Music, Debate, Sports, Hackathon and so on.

List of courses offered under Discipline Specific Elective (DSE)

Sl. No.	Semester	Course Code	Course Name	Credits
1.	III	TEC 341	Electronic Instrumentation	3
2.	III	TEC 342	Foundations of Artificial Intelligence	3
3.	III	TEC 343	Electronics Engineering Materials	3
4.	III	TEC 344	Linear Algebra (Through Swayam)	3
5.	IV	TEC 441	Semiconductor Devices and Technology	3
6.	IV	TEC 442	Basics of Nanotechnology	3
7.	IV	TEC 443	Introduction to Machine Learning (Through Swayam)	3
8.	IV	TEC 444	Analog IC Design (Through Swayam)	3
9.	V	TEC 541	Control Systems (Through Swayam)	3
10.	V	TEC 542	Electromagnetic Interference and Compatibility	3
11.	V	TEC 543	High Speed Communication Circuits	3
12.	V	TEC 544	Introduction To Probability Theory And Stochastic Processes (Through Swayam)	3
13.	V	TEC 545	Deep Learning (Through Swayam)	3
14.	VI	TEC 641	Data Communication Networks	3
15.	VI	TEC 642	Digital VLSI Circuit Design	3
16.	VI	TEC 643	Digital Video Processing	3
17.	VI	TEC 644	Fuzzy Sets, Logic and Systems & Applications (Through Swayam)	3
18.	VI	TEC 645	Multirate DSP (Through Swayam)	3
19.	VII	TEC 741	Mobile Ad hoc Networks	3
20.	VII	TEC 742	Electronics System Design	3
21.	VII	TEC 743	Design of Analog CMOS Circuit	3
22.	VII	TEC 744	Speech Processing	3
23.	VII	TEC 745	Phase-Locked Loops (Through Swayam)	3
24.	VII	TEC 746	Digital Image Processing (Through Swayam)	3
25.	VII	TEC 747	Optical Fiber Communications	3
26.	VII	TEC 748	ASIC and FPGA Design	3
27.	VII	TEC 749	Radar and Navigation Aids	3
28.	VII	TEC 750	Organic Electronics	3
29	VII	TEC 751	Computer Vision (Through Swayam)	3
30.	VII	TEC 752	VLSI Design Flow: RTL to GDS (Through Swayam)	3
31.	VIII	TEC 841	Satellite Communications	3
32.	VIII	TEC 842	Testing of VLSI circuits	3

33.	VIII	TEC 843	Digital System using VHDL	3
34.	VIII	TEC 844	Cognitive Radio	3
35.	VIII	TEC 845	Biomedical Signal Processing (Through Swayam)	3
36.	VIII	TEC 846	Digital IC Design (Through Swayam)	3
37.	VIII	TEC 851	Telecommunication Switching	3
38.	VIII	TEC 852	Optimization Methods in Machine Learning	3
39.	VIII	TEC 853	Wireless Sensor Networks	3
40.	VIII	TEC 854	Adaptive Signal Processing	3
41.	VIII	TEC 855	Spread Spectrum Communications and Jamming (Through Swayam)	3
42.	VIII	TEC 856	Sensors and Actuators (Through Swayam)	3

List of courses offered under Ability Enhancement (AEC)

Sl. No.	Semester	Course Code	Course Name	Credits
1.	I	THU 101	Professional Communication	2
2.	II	THU 201	Advanced Professional Communication	2
3.	II	GP 201	General Proficiency-I	1
4.	IV	GP 401	General Proficiency-II	1
5.	VI	GP 601	General Proficiency-III	1
6.	VIII	GP 801	General Proficiency-IV	1

List of courses offered under Skill Enhancement (SEC)

Sl. No.	Semester	Course Code	Course Name	Credits
1.	I/II	PME151/251	Workshop And Manufacturing Practices	2
2.	I/II	PME153/253	Engineering Graphics and Design Lab	2
3.	III	XCS301	Career Skills	2
4.	IV	XCS401	Career Skills	2
5.	V	XCS 501	Career Skills	2
6.	VI	XCS 601	Career Skills	2
7.	VIII	DM001	Disaster Management	2

List of courses offered under Value Added (VAC)

Sl. No.	Semester	Course Code	Course Name	Credits
1.	I/II	HSMC 101/201	Design Thinking	1
2.	III	UHV 301	Universal Human Value -II	2

List of courses offered under offered under Mandatory Non-Graded Course (MNG)

Sl. No.	Semester	Course Code	Course Name	Credits
1.	I/II	THF101/201	Healthy Living & Fitness	2
2.	I/II	TEV101/201	Environmental Science	2
3.	IV	HSS203	Constitution of India	2
4.	V	HSS304	Indian knowledge System	2

Details of Minor programs offered by other departments for Department of Electronics and Communication Engineering Students

a) Department of Computer Science and Engineering Minor Scheme

Minor in Artificial Intelligence					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Students may opt for this course**
3	TCS341	Python Programming for Computing	Programming in Python	3	60
4	TCS421	Fundamentals of Statistics and AI	Introduction to Statistics	3	60
5	TCS542	Introduction toArtificial Intelligence	An Introduction to Artificial Intelligence	3	60
6	TCS662	MachineLearning	Introduction to Machine Learning	3	60
7	TIT721	Business Intelligence	Business Intelligence & Analytics	3	60
8	TCS821	Soft Computing	Introduction To Soft Computing	3	60
Total Credits				**18**	

b) Department of Electrical Engineering Minor Scheme

Minor in Sustainable Energy Engineering					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Students may opt for thiscourse**
3	SEE301	Energy and its resources	-	3	30
4	SEE 401	Climate Change Understanding& Observations	-	3	30
5	SEE 501	Energy storage systems forrenewables	-	3	30
6	SEE 601	Electronics for Renewables	-	3	30
7	SEE 701	Solar EnergyTechnologies and System Design	-	3	30
8	SEE 801	Solar Energy System Installations and Maintenance	-	3	30
Total Credits				**18**	

c) Department of Civil Engineering Minor Scheme

Minor in Remote Sensing and GIS					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Studentsmay opt for this course**
3	TCE 399	Remote Sensing and Its Techniques	As per availability	3	30
4	TCE 499	Basic Geographical Information Systems	As per availability	3	30
5	TCE 599	Advance Geographical Information systems	As per availability	3	30
6	TCE 699	RS & GIS for Hydrology and Water Resources	As per availability	3	30
7	TCE 799	Remote Sensing and GIS in Environmental Science	As per availability	3	30
8	TCE 899	Concepts and Applications of Geospatial Technology in Natural Resources Management	As per availability	3	30
Total Credits				**18**	

d) Department of Mechanical Engineering Minor Scheme

Minor in Manufacturing and Operations					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Students may opt for this course**
3	**TME 310**	**Basic Mechanical Engineering**		**3**	**60**
4	**TME 410**	**Product Design & Manufacturing**	**Product Design and Manufacturing By Prof. J. Ramkumar, Prof. Amandeep Singh | IIT Kanpur**	**3**	**60**
5	**TME 508**	**Computer integrated Manufacturing**	**Computer Integrated Manufacturing By Prof. J. Ramkumar, Prof. Amandeep Singh | IIT Kanpur**	**3**	**60**
6	**TME 611**	**Operation management**	**Operations Management By Prof. Inderdeep Singh | IIT Roorkee**	**3**	**60**
7	**TME 710**	**Robotics and Automation**		**3**	**60**
8	**TME 819**	**Emerging areas in mechanical engineering**		**3**	**60**
			Total Credits	**18**	

e) Department of BIOTECHNOLOGY Minor Scheme

Minor in Biotechnology for Sustainability					
Semester	Course Code	Course Name	SWAYAM Course Name	Credits	Total No. Students may opt for this course
I	-	-	-	-	
II	-	-	-	-	
III	TBT 301M	Sustainable Agriculture and Organic Farming for Food Security	Organic farming for sustainable Agricultural Production	3	20
IV	TBT 401M	Bio resource Technology for Sustainable Development	-	3	20
V	TBT 501M	Circular Economy and Sustainability	-	3	20
VI	TBT 601M	Biotechnology for One Health	One Health	3	20
VII	TBT 701M	Biotechnology and Natural Resource Management	Natural Resource Management	3	20
VIII	TBT 801M	Sustainable Biomass Conversion and Bio refinery	Biomass Conversion and Bio refinery	3	20
			Total Credits	18	

f) Department of Petroleum Engineering Minor Scheme

Minor in Petroleum Drilling and Production Operations					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Studentsmay opt for this course**
Core Courses					
3	TPE 302	General Geology	Not Available	3	30
4	TPE 402	Petroleum Reservoir Engineering	Petroleum Reservoir Engineering	3	30
5	TPE 502	Well Logging andFormation Evaluation	Not Available	3	30
6	TPE 604	Petroleum Drilling Engineering	Not Available	3	30
7	TPE 701	Petroleum Production Engineering	Not Available	3	30
8	TPE 801	HSE Practices forOffshore and Petroleum Industries	HSE Practices forOffshore and Petroleum Industries	3	30
			Total Credits	**18**	

g) Department of Aerospace Engineering

Minor in Aerospace Engineering					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Students may opt for this course**
3	**TAS 310**	Fundamentals ofAerospace Engineering	Introduction toAerospace Engineering	**3**	**60**
4	**TAS 415**	Theoretical and Experimental Aerodynamics	Fundamentals of Theoretical and Experimental Aerodynamics	**3**	**60**
5	**TAS 515**	Aerospace Propulsion	Aircraft Propulsion	**3**	**60**
6	**TAS 615**	Flight Mechanics	Introduction to Airplane Performance	**3**	**60**
7	**TAS 715**	AerospaceStructures	Aircraft Structures - I	**3**	**60**
8	**ASP 802**	Project		**5**	**60**
			Total Credits	**20**	

Department of Electronics and Communication Engineering

Specialization/Honours in Internet of Things (ECE-IoT)

S. No.	Semester	Course Code	Course Name	SWAYAM Course Name	Credits
1	3rd	TEC 359	Fundamentals of Computer Organization		3
2	4th	TEC 491	Sensors and Signal Conditioning		3
3	5th	TEC 591	Transducers, Actuators and Display Devices		3
4	6th	TEC 659	Advanced Embedded Systems		3
5	7th	TEC 791	Internet of Things and Its Applications		3
6	8th	TEC 859		GPU Architectures and Programming	3
				Total Credits	**18**

Specialization/Honours in Embedded Systems and Robotics (ECE-ESR)

S. No.	Semester	Course Code	Course Name	SWAYAM Course Name	Credits
1	3rd	TEC 359	Fundamentals of Computer Organization		3
2	4th	TEC 451	Introduction to Robotics		3
3	5th	TEC 551	Sensor Technology		3
4	6th	TEC 659	Advanced Embedded Systems		3
5	7th	TEC 751		Microelectronics: Devices to Circuits	3
6	8th	TEC 859		GPU Architectures and Programming	3
				Total Credits	**18**

11. SYLLABUS

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER I/II

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 101/201***		***Course Title***	***Basic Electronics Engineering***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***3***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***First/Second***					
7.	***Category of Course***	***DSC/ESC***					
8.	***Pre-requisite***	***Physics***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** *CO1:* ***Remember*** *operations on number systems and understand concepts of digital circuits.* *CO2:* ***Understand*** *the basics of semiconductor materials and devices like, PN junction diode as well as Bipolar Junction Transistor (BJT).* *CO3:* ***Apply*** *and* ***Analyze*** *the basics of PN junction diode in rectifier circuits and BJT in Amplifier.* *CO4:* ***Design*** *and* ***develop*** *various basic electronic circuits.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Number Systems & Boolean Algebra****:* *Number systems and their conversion, Logic gates, Boolean algebra, Implementation of basic gates using universal gates, Implementation of logic functions using basic gates & universal gates, SOP & POS form of logic expression, Canonical form, Conversion from SOP & POS form to canonical form, Simplification of Boolean function: Algebraic method, Karnaugh map method (two, three & four variable K-map with don't care condition).*	*10*
2.	***Unit 2: Basics of Semiconductor Devices: P-N junction diode and BJT*** *Energy band theory: Classification of solids based on energy band diagram, Semiconductors; Intrinsic semiconductors, Extrinsic semiconductors– P-type and N-type, Mobility and conductivity, Mass action law, Charge*	*10*

	densities in semiconductors, P-N Junction; Formation of depletion region, V-I characteristics of P-N junction diode, and Zener diode. *Construction of bipolar junction transistors (BJT), NPN and PNP type transistor, Characteristics; Common base and Common emitter configuration.*	
3.	***Unit 3: AC to DC Conversion and Introduction of Operational amplifier:*** *Introduction to DC power supply, Rectifiers circuit: Half wave, Center tapped full wave and Bridge rectifier circuits. Rectifier performance parameter analysis (with and without capacitor filter).* *Introduction of Operational Amplifier: Inverting and non-Inverting Op-amp, Summing amplifier, Difference amplifier.*	*10*
	Total	***30***

11. Suggested Books

Sr. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Jacob Millmann & Halkias, "**Integrated Electronics**", TMH.*	*2nd*	*2009*
2.	*M. Morris Mano, Michael D. Ciletti, "**Digital Design**", Pearson Education.*	*5th*	*2012*
	Reference Books		
1.	*Boylestad and L. Robert and Nashelsky Louis, "**Electronics Devices and Circuits Theory**", Pearson Education,*	*10th*	*2009*
2.	*S. Salivahanan and S. Arivazhagan, "**Digital Circuits and Design**", Oxford University Press,*	*5th*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER I / II

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC151/251***		***Course Title***	***Basic Electronics Engineering Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***First/Second***					
7.	***Category of Course***	***DSC/LC***					
8.	***Pre-requisite***	***Physics***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** *CO1:* ***Identify*** *and* ***understand*** *active & passive components along with various measuring instruments.* *CO2:* ***Verify*** *truth table of logic gates.* *CO3:* ***Analyse*** *the characteristics of diodes and transistors.* *CO4:* ***Implement*** *different electronics circuits using operational amplifier and logic gates*

10. Details of the Course

Sr. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Familiarization of electronics measuring instrument and components.*	*2*
2.	*Measure the voltage and frequency using a DSO.*	*2*
3.	*Study and verification of the truth table for logic gates.*	*2*
4.	*To design and verify the truth table for logic gates using NOR gate.*	*2*
5.	*To design and verify the truth table for logic gates using NAND gate.*	*2*
6.	*Study V-I characteristics of PN junction diode and determine the static and dynamic resistance from the characteristic curve.*	*2*
7.	*Study of a Half wave rectifier circuit with and without capacitor filter.*	*2*
8.	*Study of a Centre tapped full wave rectifier circuit with and without capacitor filter.*	*2*
9.	*Study of a bridge full wave rectifier circuit with and without capacitor filter.*	*2*

10.	*Study V-I characteristics of Zener diode.*	*2*
11.	*Study the input and output characteristics of common base (CB) transistor.*	*2*
12.	*Study the input and output characteristics of common emitter (CE) transistor.*	*2*
	Total	***24***
Innovative Experiments		
13.	*Study the input and output characteristics of common collector (CC) transistor.*	*02*
14	*Design and verification of Inverting and non-inverting amplifier using Op-Amp IC.*	*02*
15.	*As suggested by the concerned faculty/lab in charge.*	*02*
	Total	***06***

11. Suggested Books

Sr. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Jacob Millmann & Halkias, "**Integrated Electronics**", TMH.*	*2nd*	*2009*
2.	*M. Morris Mano, Michael D. Ciletti, "**Digital Design**", Pearson Education.*	*5th*	*2012*
	Reference Books		
1.	*Boylestad and L. Robert and Nashelsky Louis, "**Electronics Devices and Circuits Theory**", Pearson Education,*	*10th*	*2009*
2.	*S. Salivahanan and S. Arivazhagan, "**Digital Circuits and Design**", Oxford University Press,*	*5th*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 301***		***Course Title***	***Electronic Devices and Circuits***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the working, bias stabilization, and characteristics of BJTs and MOSFETs in different regions.* ***CO2: Analyse*** *BJT/MOSFET as amplifier in different configuration and its frequency response.* ***CO3: Understand*** *and analyse multi-stage amplifiers and feedback topologies.* ***CO4****:* ***Investigate*** *the basic concepts of oscillators and their classifications.* ***CO5: Analyse*** *power amplifiers and their classification****.*** ***CO6: Design*** *BJT and MOSFET based electronic circuits.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Bipolar Junction Transistor:*** *Review of BJT, BJT as an amplifier and switch, Small signal models and analysis (CB, CE, CC), Frequency response of CE amplifier, Calculation of cut off frequencies, RC coupling. Multistage amplifier: Cascade amplifier, Darlington pair, Bootstrapping, and Cascode configuration.*	*10*
2.	***Unit 2: MOSFET and MOS Capacitor:*** *Introduction to FET, MOSFET or IGFET, DE MOSFET, E-only MOSFET, MOSFET characteristics, Q-point analysis. Introduction to MOS Capacitor, C-V Characteristics of MOS Capacitor, Mobility Models, Short Channel MOSFET I-V Characteristics, Control of threshold Voltage, Substrate Bias Effects, Subthreshold Characteristics.*	*10*

3.	***Unit 3: MOSFET as an Amplifier:*** *MOSFET biasing, MOSFET as an amplifier and switch, Biasing in MOSFET amplifier circuits, small signal models and analysis (Common Gate, Common Source, Common Drain). Frequency response of CS amplifier, Calculation of cut off frequencies.*	*9*
4.	***Unit 4: Feedback Circuits and Oscillators:*** *General feedback structure, Properties of negative feedback, Four basic feedback topologies and their analysis. Principle of sinusoidal oscillators, Types of oscillators: RC phase shift, Wein bridge, Hartley, Colpitts, Clapp and crystal oscillator.*	*9*
5.	***Unit 5: Power Amplifiers:*** *Introduction to power amplifier, Classification of power amplifier, Operation and efficiency of: Series fed class A, Transformer coupled class A, Class B push pull, Crossover distortion, Class AB push pull, Class C power amplifier.*	*7*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Millman Halkias, "**Integrated electronics**", TMH.*	*2nd*	*2001*
2.	*Boylestad L Robert, "**Electronic devices and circuit theory**", Pearson.*	*10th*	*2005*
	Reference Books		
1.	*Neaman A Donald, "**Electronics circuits**", TMH.*	*3rd*	*2014*
2.	*S. Sedra and KC Smith, "**Microelectronic Circuits**", Oxford university press.*	*5th*	*2009*
3.	*Jacob Millman and Arvin Grabel, "**Microelectronics**", TMH.*	*2nd*	*2001*
4.	*Ben G. Streetman and Sanjay Kumar Banerjee, "**Solid State Electronics Devices**", PHI Learning.*	*7th*	*2018*
5.	*Behzad Razavi, "**Fundamentals of Microelectronics**", Wiley.*	*3rd*	*2021*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 302***		***Course Title***	***Digital Electronics***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** ***CO1: Describe*** *minimization techniques for the simplification of Boolean functions and design combinational circuits.* ***CO2: Understand*** *the concepts of sequential circuits and its real time applications.* ***CO3: Apply*** *the concepts in designing of asynchronous and synchronous sequential circuits.* ***CO4: Analyse*** *and study various semiconductor memories.* ***CO5: Gain*** *knowledge of various logic families.* ***CO6: Implement*** *various digital systems.*

10. Details of the Course

Sr. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Boolean Algebra and Gate Level Minimization:*** *Review of Number System, Binary, Octal, Hexadecimal, Complements, Arithmetic Operation, Binary Codes, Basic Boolean algebra concepts, Theorems, and properties. Digital logic gates, K-Map method for minimization up to 6-variables, Quine-McClusky method for minimization, NAND and NOR gate implementation.*	*8*
2.	***Unit 2: Combinational Logic Circuits:*** *Combinational circuits, Analysis procedure, Design procedure, Binary adder & subtractor, Binary Parallel Adder, Decimal adder, Binary multiplier, Magnitude comparator, Multiplexer, Demultiplexer, Decoder, Encoder, Parity generator & checker, Code Convertors (BCD, excess-3 code, Gray code, and Seven Segment Code). Programmable logic array (PLA), Programmable array logic (PAL). Field Programmable Gate Arrays (FPGA). Designing of various combinational circuits with PAL and PLA.*	*10*

3.	***UNIT 3: Sequential Logic Circuits:*** *Triggering, Latches & Flip Flops: RS, JK, D and T (Characteristic table, Characteristic equation and excitation table), Flip Flop conversion, Race around condition, JK Master Slave Flip Flop.* ***Counter:*** *Asynchronous counter, Synchronous counters, Changing the counter modulus, Decade counter, designing of asynchronous and synchronous counters, Ring counter, Johnson counter.* ***Register:*** *Types of register, Serial in-Serial out, Serial in-Parallel out, Parallel in- Parallel out, Parallel in- Serial out, Universal shift register, Bidirectional shift register, Application of shift registers.*	*12*
4.	***Unit 4: Design of Synchronous and Asynchronous Sequential Circuit****:* *Design of Synchronous Sequential circuit, State transition diagram, State synthesis table, State reduction table, Design equations and circuit diagram, Design and analysis of asynchronous sequential circuit, Problems with asynchronous sequential circuit.*	*8*
5.	***Unit 5: Logic Family:*** *Introduction, Various characteristics of logic families, Register Transistor Logic (RTL), Diode-Transistor Logic (DTL), Transistor-Transistor Logic (TTL), Emitter Coupled Logic (ECL), NMOS and PMOS logic, CMOS logic family, CMOS transmission gate circuits.*	*7*
	Total	***45***

11. Suggested Books

Sr. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Mano M. Morris and Ciletti M.D., "**Digital Design**", Pearson Education.*	*6th*	*2021*
2.	*S. Salivahanan and S. Arivazhagan**, "Digital Circuits and Design",** Oxford University Press.*	*5th*	*2018*
	Reference Books		
1.	*Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, "**Digital Systems Principles and Applications**", Pearson Education.*	*10th*	*2007*
2.	*Donald P Leach, Albert Paul Malvino & Goutam Saha, "**Digital Principle and Application**", Tata McGraw Hill.*	*7th*	*2010*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 303***		***Course Title***	***Network Analysis and Synthesis***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***3***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
5.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electrical Engineering (TEE 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** *CO1: **Applying** various network theorems to solve electrical networks.* *CO2: **Applying** Graph theory approach to solve electrical networks.* *CO3: **Analyze** transient response and time domain analysis.* *CO4: **Understanding** the concepts of two port network in electrical systems.* *CO5: **Understanding** the concepts of coupling in Magnetically coupled circuits* *CO6: **Analysis** and Synthesis of driving point immittance functions*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Network concepts and theorems:*** *Elements and sources, node and mesh analysis, Kirchhoff's laws, Steady state sinusoidal analysis. Thevenin's, Norton's, Maximum power transfer, Tellegen's, reciprocity and superposition theorems, study of basic waveforms.*	*10*
2.	***Unit 2: Graph Theory:*** *Concept of graphs, definitions, trees, co-tree, chords and links, matrices associated with graphs, incidence matrix, circuit matrix, tie-set matrix, cut-set matrix and their KVL and KCL analysis.*	*7*
3.	***Unit 3: Network Transients:*** *Transient response, time domain analysis of simple RC, RL and RLC circuits, network analysis using Laplace transform, driving point and transfer function, resonance in electrical circuits.*	*10*
4.	***Unit 4: Two Port Network and Coupling Circuit:*** *Different two port parameters, condition of reciprocity and symmetry for different two port parameters, inter relationship between different two port*	*9*

	parameters, interconnection of two port networks. Coupled Circuits: Self-inductance and Mutual inductance, Coefficient of coupling, dot convention, Analysis of Magnetic Coupling Circuits.	
5.	***Unit 5: Network Function and Synthesis:*** *Driving point function, transfer function, Positive real function; definition and properties, poles and zeroes of network functions, Hurwitz polynomials, properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point admittance functions using Foster and Cauer first and second forms.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Kemmerly, Hayt and Durbin, "**Engineering Circuit Analysis**", TMH.*	*7th*	*2010*
2	*Van Valkenburg, M.E., "**Network Analysis & Synthesis**", PHI/ Pearson education.*	*3rd*	*2002*
	Reference Books		
1.	*Alexander, Charles K., Sadiku, Matthew N. O., "**Fundamentals of Electric Circuits**", Mc-Graw Hill.*	*5th*	*2004*
2	*Irwin David J./ R.Mark Nelms, "**Basic Engineering Circuit Analysis**", John Wiley.*	*8th*	*2013*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 304***		***Course Title***	***Signals and Systems***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Engineering Mathematics I (TMA101) & II (TMA201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** *CO1:* ***Differentiate*** *between various types of signals and* ***understand*** *the implication of operations of signals.* *CO2:* ***Understand*** *and* ***classify*** *systems based on the impulse response behaviour of both continuous time and discrete-time systems.* *CO3:* ***Apply*** *Fourier series for continuous-time signals.* *CO4:* ***Apply*** *Fourier Transform for continuous-time signals.* *CO5:* ***Explain*** *the Laplace transform and its importance to analyse signals and systems.* *CO6:* ***Design*** *and* ***develop*** *LTI systems and its response in time and frequency domain*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Continuous-time and Discrete-time Signals:*** *Introduction to signal, Classification of signals: continuous /discrete-time, Analog/ digital signal, Periodic/ aperiodic, Even/odd, Energy/power, Deterministic/random, Commonly used continuous-time signals and discrete-time signals: Unit step, Unit ramp, Exponential, Rectangular pulse, Unit impulse, Operation on continuous –time and discrete time signals: Addition, Multiplication, Differentiation/difference, Integration/ accumulation, Shifting, Scaling, Folding.*	*10*
2.	***Unit 2: Introduction to Continuous-time and Discrete-time Systems****:* *Classification of systems: Static and dynamic, Linear, and non-linear, Time-variant and time invariant, Causal, and non-causal, Stable and unstable, Continuous time and discrete time LTI system, Impulse response and step response of LTI systems, Convolution integral/ convolution sum, Properties of LTI system.*	*10*
3.	***Unit 3: Fourier Series Analysis of Continuous-time Signals:***	*9*

	Introduction, Vector space representation by ortho-normal vectors and signal space representation by orthogonal signal set, Fourier series representation of periodic signals, Convergence of Fourier series, Trigonometric Fourier series and exponential Fourier series, Properties of the continuous time Fourier series. Power content of a periodic signal.	
4.	***Unit 4: Continuous Time Fourier Transform:*** *Deriving Fourier transform from Fourier series, Convergence of the Fourier transforms, Fourier transform of standard signals, Properties of Fourier transforms, Inverse Fourier Transform, Convolution, Parseval's theorem.*	*8*
5.	***Unit 5 Laplace Transform:*** *Introduction to Laplace transform, Relation between Laplace and Fourier transforms, Region of convergence for Laplace transform, Properties of ROC, Laplace transform of some common signals, Properties of the Laplace transform, Convolution, Unilateral Laplace transform, Inverse Laplace transform and initial value and final value theorem.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*Alan. V. Oppenheim, Alan. S. Willsky, and S. Hamid Nawab, "**Signals and Systems**", Prentice-Hall, Inc.*	*2nd*	*2001*
2.	*Simon Haykin, and Barry VanVeen, "**Signals and systems**", John Wiley & Sons.*	*2nd*	*2007*
3.	*P. RamaKrishna Rao and Shankar Prakriya, "**Signals and Systems**", McGraw Hill Education Private Limited.*	*2nd*	*2013*
	Reference Books		
1.	*B. P. Lathi, "**Signal processing and linear systems**", Oxford university press.*	*1st*	*2009*
2.	*R.F. Ziemer, W.H. Tranter and D.R. Fannin, **"Signals and Systems - Continuous and Discrete"**, Pearson New International Edition.*	*4th*	*2014*
3.	*H. P. Hsu, "**Signal and Systems**", McGraw Hill Publications.*	*2nd*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 301***		***Course Title***	***Electronics Circuit Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/LC***					
8.	***Pre-requisite***	***Basic Electronics Engineering Lab (PEC 151/251)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Remember*** *the different electronic components and testing the characteristics of rectifiers in CRO.* ***CO2: Analyse*** *the characteristics of regulated power supply, amplifiers and oscillator circuits with simulation in OrCAD.* ***CO3: Evaluate*** *amplifier circuits to compute gain and frequency response* ***CO4: Design and implement*** *analog circuits on PCB followed by soldering and testing*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Simulation of half wave and full wave center tapped rectifiers through OrCAD software.*	*1*
2.	*Simulation of DC regulated power supply (+5V) through OrCAD software.*	*1*
3.	*To implement the circuits of Half wave and Full wave center tapped rectifiers on the bread board and draw/measure the outputs with and without filter.*	*2*
4.	*Simulation of CE Amplifier using PSPICE OrCAD.*	*1*
5.	*Simulation of two stage RC Coupled Amplifier using PSPICE OrCAD.*	*1*
6.	*To implement the circuit of single stage common emitter (CE) amplifier on the bread board and draw its output and frequency response curve.*	*2*
7.	*Simulation of FET amplifier circuit using OrCAD and compute the gain and bandwidth.*	*1*
8.	*Simulation of Hartley oscillator using PSPICE OrCAD and determine its frequency of oscillation.*	*1*
9.	*Simulation of Wein Bridge oscillator using PSPICE OrCAD and determine its frequency of oscillation.*	*1*

10.	*Simulation of RC Phase shift oscillator using PSPICE OrCAD and determine its frequency of oscillation.*	*1*
11.	*Simulation of COLPITTS oscillator using PSPICE OrCAD and determine its frequency of oscillation.*	*1*
12.	*To develop the negative of full wave center tapped rectifier/DC regulated power supply.*	*2*
13.	*To make the PCB of full wave center tapped rectifier/DC regulated power supply.*	*2*
14.	*To drill and solder the components on the PCB of full wave center tapped rectifier/DC regulated power supply.*	*2*
15.	*To test the PCB of full wave center tapped rectifier/DC regulated power supply.*	*1*
	Total	***20***
Innovative Experiments		
16.	*To make the Layout of center tapped full wave rectifier through OrCAD software.*	*1*
17.	*To make the Layout of DC regulated power supply through OrCAD software.*	*1*
	Total	***2***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*S. Sedra and KC Smith, "**Microelectronic Circuits**", Oxford university press.*	*5th*	*2009*
2.	*Millman Halkias, "**Integrated electronics**", TMH.*	*2nd*	*2001*
3.	*Boylestad L Robert, "**Electronic devices and circuit theory**", Pearson.*	*10th*	*2005*
	Reference Books		
1.	*Jacob Millman and Arvin Grabel, "**Microelectronics**", TMH.*	*2nd*	*2001*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 302***		***Course Title***	***Digital Electronics Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Basic Electronics Engineering Lab (PEC 151/251)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *various logic gates and digital circuits.* ***CO2: Identify*** *various digital ICs and understanding its operation.* ***CO3: Design*** *elementary digital circuits under real and simulated environment.* ***CO4: Simulate*** *various logic circuits using simulation tool.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*To verify the truth table of basic logic gates (AND, OR, NOT, NAND, NOR, XOR). To realize basic two input Boolean AND, OR logic functions using discrete components.*	*2*
2.	*To verify the Consensus Theorem (Boolean algebra functions) using universal digital IC Gates.*	*2*
3.	*To design and test a half/full adder circuit using digital IC gates.*	*2*
4.	*To design and test a half/full subtractor circuit using IC gates.*	*2*
5.	*To design, implement and test the function F(A,B,C,D)=m(1,3,5,7,9,15)+d(4,6,12,13) using a NOR-OR implementation.*	*2*
6.	*To design and test RS, JK, D and T flip flops using logic gates.*	*2*
7.	*To design and test shift registers using flip-flops.*	*2*
8.	*To design and test an asynchronous up/down counter.*	*2*
9.	*To design, implement and test half/full adder/subtractor functions using a multiplexer.*	*2*
10.	*To design and simulate the implementation of BCD TO EXCESS 3-CODE CONVERTER using OrCAD/PSPICE.*	*2*
11.	*To design and simulate the implementation of ring counter using OrCAD/PSPICE.*	*1*

	Total	***21***
Innovative Experiments		
12..	*To design, implement and simulate half & full adders using OrCAD/PSPICE.*	*1*
13.	*To design, implement and simulate half & full subtractors using OrCAD/PSPICE.*	*1*
	Total	***2***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Mano M. Morris and Ciletti M.D.**,** "**Digital Design**", Pearson Education*	*6th*	*2021.*
2.	*S. Salivahanan and S. Arivazhagan, "**Digital Circuits and Design**", Oxford University Press*	*5th*	*2018*
	Reference Books		
1.	*Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, "**Digital Systems Principles and Applications**", Pearson Education,*	*10th*	*2007.*
2.	*Donald P Leach, Albert Paul Malvino & Goutam Saha, "**Digital Principle and Application**", Tata McGraw Hill*	*7th*	*2010*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 341***		***Course Title***	***Electronic Instrumentation***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Explain*** *the significance and characteristics of an Electronic Measurement System.* ***CO2: Demonstrate*** *the use of transducers in measuring physical parameters.* ***CO3: Design*** *an appropriate signal conditioner for real time signal acquisition using DAQ.* ***CO4: Implement*** *different control schemes in managing real time process variables.* ***CO5: Apply*** *communication protocols in managing process variables remotely.* ***CO6: Develop*** *the skills in real time measurement by the use of signal conditioners, Data Acquisition systems and Data loggers.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Electronic Instruments:*** *Electronic Instruments and its classification, Elements of a Generalized Measurement System; Characteristics of instruments, Static characteristics, Errors in measurements, scale, range, and scale span, calibration, Reproducibility and drift, Noise, Accuracy and precision, Linearity, Hysteresis, Threshold, Dead time, Dead zone, Resolution and Loading Effects. Analog and Digital Instruments.*	*10*
2.	***Unit 2: Transducers & Actuators:*** *Definition, Classification, Principle of Analog transducers: Resistive (Strain Gauge, POT, Thermistor and RTD), Capacitive, Piezoelectric, Thermocouple and Inductive (LVDT) and RVDT) transducer, Working principle of Digital Transducers and Optical transducers, Actuators: Pneumatic cylinder, Relay, solenoid (Final Control Element).*	10

3.	***Unit 3: Instrumentation systems:*** *Introduction to Instrumentation system, Types of Instrumentation system, Data acquisition system, its objectives, and its uses in intelligent Instrumentation system, Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal Converters (ADC & DAC), Sample and hold, Data logger.*	9
4.	***Unit 4: Controllers:*** *Concepts of Control Schemes, Types of Controllers, Continuous Controllers: P, PI, PID controllers, Discrete Controllers, Programable logic Controller (PLC), Intelligent Controllers*.	8
5.	***Unit 5: Telemetry & Instrument interfacing*** *Introduction to telemetry, Instrument interfacing, Current loop, RS232/485, Field bus, Modbus, GPIB, USB Protocol, HART communication Protocol-Communication modes and networks.*	8
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*A. K. Sawhney, "**Electrical and Electronic Measurements and Instrumentation**", Dhanpat Rai and Sons, New Delhi*	*3rd*	*1995*
2.	*H.S Kalsi, "**Electronic Instrumentation**", Tata McGraw Hill*	*3rd*	*2012*
3.	*Krishna Kant, "**Computer Based Industrial Control**", PHI*	*2nd*	*2010*
	Reference Books		
1.	*Curtis D. Johnson, "**Process Control Instrumentation**", Pearson Education.*	*8th*	*2006*
2.	*Helfrich & Cooper, "**Modern Electronic Instrumentation & Measurement Techniques**", PHI*	*2nd*	*1997*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 342***		***Course Title***	***Foundations of Artificial Intelligence***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Engineering Mathematics-I (TMA 101), Engineering Mathematics-II(TMA 201).***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* *CO1: To* ***learn*** *the concepts of artificial intelligence.* *CO2: To* ***study*** *problem solving techniques.* *CO3: To* ***understand*** *the representation of knowledge and reasoning mechanism.* *CO4: To* ***learn*** *planning and decision making.* *CO5: To* ***study*** *network models used for learning.* *CO6:* ***Develop*** *approaches for real time applications to produce "intelligent" systems, Knowledge representation (both symbolic and neural network), search and machine learning.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to AI:*** *Problem Solving as State Space Search, Uniformed Search, Heuristic Search, Informed Search, Constraint Satisfaction Problems, Searching AND/OR Graphs.*	10
2.	***Unit 2: Knowledge representation and Reasoning:*** *Introduction to Knowledge Representation, Propositional Logic, First Order Logic –I, First Order Logic –II, Inference in First Order Logic-I, Inference in First Order Logic – II, Answer Extraction, Procedural Control of Reasoning, Reasoning under Uncertainty, Bayesian Network, Decision Network.*	10
3.	***Unit 3: Planning and decision Making:*** *Introduction to Planning, Plan Space Planning, Planning Graph and Graph Plan, Practical Planning and Acting, Sequential Decision Problems, Making Complex Decisions.*	10
4.	***Unit 4: Machine Learning:***	10

	Introduction to Machine Learning, Learning Decision Trees, Linear Regression, Support Vector Machines, Unsupervised Learning, Reinforcement Learning,	
5.	***Unit 5: Deep Learning:*** *Introduction to deep learning, neural network learning, Architecture of neural network.*	5
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Patrick Henry Winston, "**Artificial Intelligence**", Addison-Wesley Publishing Company.*	*3rd*	*2004*
2.	*Stuart Russell and Peter Norvig, "**Artificial Intelligence: A Modern Approach**", PHI .*	*3rd*	*2009*
	Reference Books		
1.	*Nils J. Nilsson, "**Quest for Artificial Intelligence**", Cambridge University Press.*	*1st*	*2010*
2.	*Nils J Nilsson**, "Principles of Artificial Intelligence**", Springer Heidelberg.*	*Illustrated Reprint Edition*	*2014*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 343***		***Course Title***	***Electronics Engineering Materials***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Physics, Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Understanding*** *of crystallinity of electronic materials.* ***CO2: Ability*** *to develop free electron concept in various types of electronic materials.* ***CO3: Develop*** *the concept of optoelectronic and dielectric properties of the materials.* ***CO4: Explanation*** *of magnetic behaviour of electronic materials.* ***CO5: Discuss*** *the capacitive, resistive, and superconductivity of the material.* ***CO6: Application*** *of material in electronic devices according to their properties*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Crystal Structure:*** *Crystalline state, bravais lattices, Miller indices, reciprocal lattice, common crystal structures, interference phenomenon, Bragg's diffraction, crystal imperfections.*	*9*
2.	***Unit 2: Free Electron Theory:*** *Conduction in metals and alloys, conductors, Semiconductors and resistors, Growth of single crystals, zone refining technique. Semiconductor properties and their applications.*	*9*
3.	***Unit 3: Optoelectronics and Dielectric Materials:*** *Electric and optical properties, polarization in static and alternating field, piezoelectricity, polarizability and dielectric constant, optical transition in solids, absorption and emission of radiation.*	*9*
4.	***Unit 4: Magnetism:***	*10*

	Magnetic properties of materials, diamagnetism, para-magnetism, ferromagnetism, black well, domain dimensions, anti-ferromagnetism, and ferromagnetism, ferrites, Magnetic Materials: Fe, Si, Ni, Co, Hard magnetic materials.	
5.	***Unit 5: Superconducting Materials:*** *Materials for resistors, capacitors and inductors, properties and application of plastic materials, Superconductivity and superconductors.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Azároff, Leonid V, "**Electronic processes in materials**", McGraw-Hill Education*	*7th*	*2019*
2.	*V. Raghavan, "**Material Science and Engineering**", PHI*	*6th*	*2015*
	Reference Books		
1.	*K.M. Gupta and Nishu Gupta, "**Advanced Electrical and Electronics Materials**", John Wiley*	*1st*	*2016*
2.	*Robert E. , "**Physical Metallurgy Principles**", Reed-Hill*	*4th*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 359***		***Course Title***	***Fundamentals of Computer Organization***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Three***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/ TEC 201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** ***CO1: Recall*** *the concepts of computer system and its organization.* ***CO2: Understand*** *different Computer Arithmetic operations and algorithms.* ***CO3: Understand*** *different addressing modes and instruction formats.* ***CO4: Analyse*** *memory organization, cache memory mapping and paging to improve performance.* ***CO5: Assess*** *and evaluate processor organization and control unit.* ***CO6: Develop*** *the concepts of computer organization for better understanding of courses, such as embedded system and robotics.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Structure of a computer system, Functional components of a computer, Historical development: First through fourth generation computers, Moore's law, The Von Neumann and Non Von Neumann model.*	***9***
2.	***Unit 2: Machine Instructions:*** *Memory location and addresses, Operands, Addressing modes, Instruction formats, Instruction sequencing, Execution of a complete instruction, Instruction set architectures - CISC and RISC architectures.*	***9***
3.	***Unit 3: Computer Arithmetic:*** *Addition and subtraction, Arithmetic circuit, Multiplication algorithms, Division algorithms, Floating-point representation, Floating point arithmetic operations, BCD adder.*	***8***
4.	***Unit 4: Processing Unit:***	***8***

	Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit, Operations of a control unit, Hardwired control unit, Microprogrammed control unit.	
5.	***Unit 5: Memory Subsystem:*** *Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal organization of a memory chip, Cache memory unit, Concept of cache memory, Mapping methods, Organization of a cache memory unit, Effective Access time and Hit ratio, Virtual memory, Paging, Advantages and disadvantages of paging.*	***11***
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*William Stallings, "**Computer Organization & Architecture Designing for Performance**", Prentice Hall Education.*	*8th*	*2010*
2.	*Carl Hamacher, ZvonkoVranesic, SafwatZaky, "**Computer Organization**", Tata McGraw Hill.*	*5th*	*2011*
	Reference Books		
1.	*David A. Patterson, John L. Hennessy, "**Computer Organization and Design – The Hardware / Software Interface**", Morgan Kaufmann, Elsevier*	*5th*	*2013*
2.	*John P. Hayes, "**Computer Architecture and Organization**", Tata McGraw Hill.*	*3rd*	*2012*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 401***		***Course Title***	***Communication Systems I***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Signals & Systems (TEC 304)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* *CO1:* ***Demonstrate*** *and* ***understand*** *different methods of amplitude modulation and demodulation schemes, their design, operation and applications.* *CO2:* ***Demonstrate*** *and* ***understand*** *different methods of angle modulation and demodulation schemes, their design, operation and applications.* *CO 3:* ***Understand*** *the random variable, random process and their application for Noise analysis.* *CO4:* ***Demonstrate*** *and* ***understand*** *different methods of pulse modulation, their design, operation and applications.* *CO5:* ***Evaluate*** *the performance of analog communication system in the presence of noise.* *CO6:* ***Apply*** *the concepts of Analog modulation and demodulation for radio & TV receivers*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Amplitude Modulation Systems:*** *Modulation, Need of modulation, Model of communication system, Amplitude Modulation: Equation for AM wave, Modulation index, Power and current relationships, Transmission and power efficiency, Generation and demodulation of DSB-FC, DSB-SC, SSB-SC and VSB signals, Spectral characteristics of amplitude modulated signals, Comparison of amplitude modulation systems.*	*10*
2.	***Unit 2: Angle Modulation Systems:*** *Phase and frequency modulation: Narrow band and wideband FM & PM, Spectral characteristics of angle modulated signals, Generation and demodulation of FM Signal, PLL.*	*11*

3.	***Unit 3: Noise:*** *Introduction – internal and external noise, Noise equivalent bandwidth, S/N ratio, Noise figure, Equivalent noise temperature, Equivalent Noise figure for Cascade connection of two port network. Equivalent noise temperature for Cascade connection of two port network.*	*8*
4.	***Unit 4: Pulse Analog Modulation System:*** *Sampling process, Pulse amplitude modulation, Pulse duration modulation, Pulse position modulation.*	*7*
5.	***Unit 5: SNR Performance of Continuous Wave Modulation Systems:*** *Introduction: Review of probability and random process. Gaussian and white noise characteristics, Analog communication model, SNR calculation in DSB-SC, SSB-SC, DSB-FC, FM & PM systems, FM threshold effect; Pre-emphasis and De-emphasis in FM, Comparison of performances.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*B. P. Lathi, "**Modern Digital and Analog Communication**", Oxford Publication.*	*3rd*	*2005*
2.	*Simon Haykin, "**Communication Systems**", John Willey.*	*4th*	*2001*
3.	*Taub and Schilling, "**Principles of Communication System**", Tata McGraw-Hill.*	*4th*	*1995*
4.	*HWEI HSU, "**Analog and Digital Communications**", Schaum Outline Series.*	*2nd*	*2003*
	Reference Books		
1.	*Roddy and Coolen, "**Electronic Communication**", Prentice Hall of India.*	*4th*	*1998*
2.	*Singh and Sapre, "**Communication system**", TMH.*	*2nd*	*2007*
3.	*A. Papoulis, "**Probability, Random variables and Stochastic processes**", MGH.*	*4th*	*2002*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 402***		***Course Title***	***Analog Integrated Circuits***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Electronics Devices and Circuits (TEC 301)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* *CO1:* ***Identify*** *various configurations of differential amplifier.* *CO2:* ***Understand*** *the concepts of ideal and practical operational amplifiers (Op-Amp).* *CO3:* ***Apply*** *the concepts of Op-Amp in designing of the linear and non-linear integrated circuits.* *CO4:* ***Analyse*** *the performance parameters of active filters using Op-Amp.* *CO5:* ***Evaluate*** *the performance parameters of oscillators and multivibrators using Op-Amp.* *CO6:* ***Design*** *voltage regulator circuits using Op-Amp.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Differential amplifier and OP-AMP Fundamentals:*** *DC and AC analysis of various configuration of differential amplifier, Input stage, Intermediate stage circuits, Constant current bias circuits, Current mirror, Active load, Level shifter, Output stage.*	*10*
2.	***Unit 2: Operational Amplifier Applications:*** *Inverting/Non-inverting amplifier: Calculation of input and output impedance along with feedback gain, Summer amplifier, Difference amplifier, Integrator, Differentiator, VCVS, CCVS, VCCS, and CCVS, Instrumentation amplifier*	*10*
3.	***UNIT 3: Non-linear Circuits:*** *Logarithmic amplifier, Log/Antilog modules, Precision rectifier, OP-AMP as comparator. Oscillators (Hartley, Colpitts, RC phase shift), Multivibrators: Astable, Monostable and Bistable, Triangular wave generator, 555 timer and it's applications, PLL & capture range.*	*10*
4.	***Unit 4: Active Filters:***	*8*

	Butterworth filter: Low pass filter, High pass filter, Band pass filter, Band-reject Filter, Sallen-Key unity gain filter, Sallen-Key equal component filter and its performance parameters: Gain, Cut-off frequency, Frequency response, State variable filter.	
5.	**Unit 5: Voltage Regulators:** *Series Op-amp regulators, IC voltage regulators, 723 general purpose regulator, Switching regulators, Fixed voltage (78/79, XX) regulators.*	*7*
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*Sedra and Smith, "**Microelectronic Circuits**", Oxford University press.*	*5th*	*2019*
2.	*J. Michael Jacob, "**Applications and design with Analog Integrated Circuits**", PHI.*	*2nd*	*2010*
	Reference Books		
1.	*B. Razavi, "**RF Microelectronics**", Prentice Hall.*	*2nd*	*2011*
2.	*B.P. Singh and Rekha Singh, "**Electronic Devices and Integrated Circuits**", Pearson Education.*	*1st*	*2012*
3.	*Ramakant A. Gayakwad, "**Op-Amps and Linear Integrated Circuits**", PHI.*	*3rd*	*2009*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 403***		***Course Title***	***Microprocessor and its Applications***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Digital Electronics (TEC 302)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** *CO1:* ***Remember*** *the concept of microcomputer system.* *CO2:* ***Understand*** *microprocessor 8085 and 8086 hardware.* *CO3:* ***Apply*** *the concepts of assembly language programming of 8085 and 8086 to fulfil different tasks.* *CO4:* ***Examine*** *the application of 8085 and 8086 microprocessors with interrupt system, real time timer and counter.* *CO5:* ***Test*** *different interfacing ICs and memory for defined tasks with 8085 and 8086 microprocessors.* *CO6:* ***Integrate*** *the knowledge of 8085 and 8086 in various embedded systems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Microprocessors:*** *Evolution of microprocessors, Microprocessor internal architecture, hardware model of 8085, Pin diagram.*	*8*
2.	***Unit 2: Programming with 8085:*** *Instruction set, Programming model of 8085, Addressing modes, Assembly language programming, Timing Diagram, Peripheral I/O, Memory mapped I/O, 8085 Interrupts, Stack and subroutines.*	*10*
3.	***UNIT 3: 16-bit microprocessors (8086):*** *Architecture, Pin diagram, Physical address, Segmentation, Memory organization, addressing modes, Instruction set, Assembly language programming of 8086, Comparison of 8086 & 8088 microprocessor.*	*10*
4.	***Unit 4: Interfacing with Microprocessor:*** *Data transfer schemes, Handshaking signals, Types of transmission, 8255 (PPI), Serial data transfer (USART 8251), Memory interfacing, 8257 (DMA), Programmable interrupt controller (8259).*	*9*

5.	***Unit 5: Interfacing of Microprocessor with Timing Devices:*** *Programmable interval timer/ counter (8253/8254), Introduction, Modes, Interfacing of 8253 & it's applications, Introduction to DAC & ADC, ADC & DAC Interfacing (0808, 0809).*	*8*
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*Ramesh Gaonkar, "**Microprocessor Architecture**, **Programming, and Applications with the 8085**", Penram International Publication (India) Pvt. Ltd.*	*6th*	*2013*
2.	*A. K. Ray & K. M. Bhurchandi, "**Advanced Microprocessors and peripherals", Tata McGraw Hill.*	*3rd*	*2012*
	Reference Books		
1.	*Douglas V. Hall, "**Microprocessors and Interfacing**", Tata McGraw Hill.*	*3rd*	*2012*
2.	*Barry B. Brey, "**The Intel Microprocessors Architecture Programming and interfacing**", Pearson.*	*8th*	*2012*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 404***		***Course Title***	***Electromagnetic Field Theory***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	**Physics, Engineering Mathematics *(TMA 101/201)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** *CO1:* ***Understand*** *the concept of vector algebra, gradient, divergence and curl.* *CO2:* ***Differentiate*** *among different types of coordinate systems and apply them for solving the problems of electromagnetic field theory.* *CO3:* ***Analyse*** *the electric field and magnetic field for various structures.* *CO4:* ***Evaluate*** *E-M wave parameter in different medium.* *CO5:* ***Model*** *Transmission line and its various parameter.* *CO6:* ***Analyse*** *the behaviour of E and H field in parallel-plate geometry..*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Coordinate System and Vector Calculus:*** *Vector multiplication, Components of vector, Co-ordinate systems and their transformation, Differential length, area and volume, Line, Surface, Volume integral, Gradient of a scalar field, Divergence of a vector field, Curl of a vector field, Laplacian of a Scalar, Divergence theorem, and Stoke's theorem.*	*10*
2.	***Unit 2: Static Fields:*** *Electric field intensity, Electric flux density, Gauss' law & its application, Electrostatic potential, Poisson's & Laplace equation, Energy density in electrostatics field, Dielectric constant, Continuity equation, Boundary condition in electrostatics,* ***Biot-Savart law****, Ampere's law & its application, Magnetic flux density,* ***Force due to magnetic field****, Magnetic energy, Boundary condition in magnetostatics.*	*12*
3.	***Unit 3: Maxwell's Equation and Electromagnetic Wave Propagation:*** *Faraday Law, Displacement Current, Generalised Maxwell's equation, Time Harmonic Maxwell's Equation, Uniform plane waves, Poynting theorem,*	*9*

	Wave polarization, Reflection & refraction of a plane wave at normal incidence & oblique incidence.	
4.	***Unit 4: Introduction to Transmission Lines:*** *Transmission line parameters, Transmission line equations, Input impedance, Reflection coefficient & Standing wave ratio,* ***Power,*** *Quarter wave transformer and impedance matching through single stub using smith chart.*	*8*
5.	***Unit 5: Parallel Plate Waveguide:*** *Analysis of Transverse Electric (TE) mode, Transverse Magnetic (TM) Mode and Transverse Electromagnetic Mode (TEM)..*	*6*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Mathew N.O. Sadiku, "**Principles Of Electromagnetics**", Oxford University Press*	*6th*	*2017*
2.	*Hyatt, William, "**Engineering Electromagnetics**", McGraw Hill*	*9th*	*2020*
	Reference Books		
1.	*E.C. Jordan and K.G. Balmain, "**Electromagnetic Waves and Radiating System**", Pearson.*	*2nd*	*2015*
2.	*J. Kraus, D. Fleisch, "**Electromagnetics with Applications**", McGraw Hill.*	*5th*	*2017*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 401***		***Course Title***	***Communication Systems-I Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/LC***					
8.	***Pre-requisite***	***Knowledge of DSO and fundamentals of MATLAB.***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Demonstrate*** *understanding and analyzing the waveforms of DSB-FC, DSB-SC and SSB-SC.* ***CO2: Analyzing*** *different amplitude modulation techniques (DSB-FC, DSB-SC) angle modulation techniques (FM & PM) using MATLAB.* ***CO3: Understanding*** *and* ***analyzing*** *of different angle modulation techniques (FM & PM).* ***CO4: Understanding*** *and* ***analyzing*** *of Pulse amplitude modulated & demodulated waveforms.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Generation of amplitude modulated (DSB-FC) waveform and determines the modulation indices.*	*2*
2.	*Generation of Double sideband suppressed carrier (DSB-SC) waveform using balanced modulator.*	*2*
3.	*Generation of single sideband suppressed carrier (SSB-SC) signal.*	*2*
4.	*Generation of frequency modulated (FM) signal using voltage-controlled oscillator.*	*2*
5.	*Demodulation of FM signal using phase locked loop (PLL).*	*2*
6.	*Generation and detection of PAM.*	*2*
7.	*Generation and detection of PWM & PPM.*	*2*
8.	*Simulation of Double sideband suppressed carrier (DSB-SC) signal using MATLAB.*	*2*
9.	*Simulation of amplitude modulated (DSB-FC) signal using MATLAB.*	*2*
10.	*Simulation of Single sideband suppressed carrier (SSB-SC) signal using MATLAB.*	*2*
11.	*Simulation of frequency modulated (FM) signal using MATLAB.*	*2*

12.	*Simulation of phase modulated (PM) signal using MATLAB.*	*2*
13.	*Simulation of Frequency division Multiplexing (FDM) using MATLAB.*	*2*
	Total	***26***
Innovative Experiments		
14.	*To analyse the radiation pattern of Yagi-Uda antenna.*	*2*
15.	*Getting familiar with the features and basic operations of the spectrum analyzer and investigating signals in frequency domain.*	*2*
16.	*To plot the frequency domain representation of DSB-FC, DSB-SC and SSB-SC using MATLAB.*	*2*
17.	*To plot the frequency domain representation of FM, and PM using MATLAB.*	*1*
18.	*To demonstrate the effect of AWGN in DSB-FC, DSB-SC and SSB-SC using MATLAB.*	*1*
19.	*Simulation of frequency modulation and demodulation in noisy condition using MATLAB.*	*1*
	Total	9

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*B. P. Lathi, "**Modern Digital and Analog Communication**", Oxford Publication,*	*3rd*	*2005*
2.	*Simon Haykin, "**Communication Systems**", John Willey.*	*4th*	*2001*
	Reference Books		
1.	*Roddy and Coolen, "**Electronic Communication**", Prentice Hall of India.*	*4th*	*1998*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 402***		***Course Title***	***Analog Integrated Circuits Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Electronics Circuits Lab (PEC 301)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Understand*** *the concepts of open loop/closed loop Op-Amp configurations.* ***CO2: Analyse*** *the performance parameters of Active Filters using Op-Amp.* ***CO3: Evaluate*** *the performance characteristics of comparator and multi-vibrator circuits using OP-AMP.* ***CO4: Design*** *various linear and non-linear circuits using Op-Amp.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Design and Test open loop inverting and non-inverting op-amp.*	*2*
2.	*Design and Test closed loop inverting and non-inverting op-amp.*	*2*
3.	*Design and Test op-amp based adder and subtractor circuits.*	*2*
4.	*Design and Test op-amp based integrator circuits.*	*2*
5.	*Design and Test op-amp based differentiator circuits.*	*2*
6.	*Design and Test op-amp based active RC low pass filters.*	*2*
7.	*Design and Test op-amp based active RC high pass filters.*	*2*
8.	*Design and Test op-amp based active Band pass filter.*	*2*
9.	*Design and Test op-amp based comparator circuits.*	*2*

10.	*Realize op-amp based triangular wave generator.*	*2*
11.	*Analyze CMRR and slew rate of Op-Amp.*	*2*
12.	*Design and test astable and monostable-multivibrator circuits using 555 timer.*	*2*
	Total	***24***
Innovative Experiments		
13.	*To design, implement and simulate half & full subtractors using OrCAD/PSPICE.*	*2*
14.	*Design and test unity gain sallen key low pass filter.*	*2*
15.	*Design band reject filter.*	*2*
16.	*Design and test Op-amp based PLL.*	*2*
	Total	8

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Sedra and Smith, "**Microelectronic Circuits**", Oxford University press, Edition,*	*5th*	*2019.*
2.	*J. Michael Jacob, "**Applications and design with Analog Integrated Circuits**", PHI, Edition,*	*2nd*	*2010.*
	Reference Books		
1.	*B. Razavi, "**RF Microelectronics**", Prentice Hall, Edition,*	*2nd*	*2011.*
2.	*B.P. Singh and Rekha Singh, "**Electronic Devices and Integrated Circuits**", Pearson Education, Edition,*	*1st*	*2012.*
3.	*Ramakant A. Gayakwad, "**Op-Amps and Linear Integrated Circuits**", PHI*	*3rd*	*2009.*
4.	*Behzad Razavi, "**Fundamental of Microelectronics**", Wiley*	*3rd*	*2021.*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 403***		***Course Title***	***Microprocessor Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Digital Electronics Lab (PEC 302)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *8085 and 8086 instruction set.* ***CO2: Understand*** *different assembly language programs on microprocessor-based microcomputer kit.* ***CO3: Apply*** *the programming concepts to test and debug assembly language programs in the laboratory.* ***CO4: Assemble*** *various devices and memories with microprocessor for any defined task.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Write program in 8085 to swap two 8-bit numbers.*	*2*
2.	*Write a program in 8085 to move a block of data bytes from one location to another location.*	*1*
3.	*Write programs in 8085 to perform addition & subtraction of 8-bit number with carry / borrow.*	*1*
4.	*Write a program in 8085 for addition of 16 bits numbers with carry.*	*1*
5.	*(a) Write an ALP in 8085 to find one's complement of 8 /16bit data.* *(b) Write an ALP in 8085 to find two's complement of 8/16 bit data.*	*1*
6.	*Write an ALP in 8085 to add two 8-bit BCD data.*	*1*
7.	*(a) Write an ALP in 8085 to find larger number between two numbers.* *(b) Write an ALP in 8085 to find smaller number between two numbers.*	*1*
8.	*Write an ALP in 8085 to find largest /smallest in a series of 'n' number.*	*1*
9.	*Write a program to find square root of a number in 8085.*	*1*
10.	*(a) Write a program in 8086 to add two 16-bit numbers given by the user.*	*2*

	(b) Write a program in 8086 to subtract two 16-bit numbers given by the user.	
11.	*(a) Write a program in 8086 to multiply two 16-bit data.* *(b) Write a program in 8086 to divide: 32-bit data by 16-bit data.*	*2*
12.	*(a) Write a program in 8086 to find the largest no. from an array of 'n' numbers stored in an array.* *(b) Write a program in 8086 to perform sorting of given set of numbers.*	*2*
13.	*Write a program in 8086 to add and subtract two 8-bit BCD numbers.*	*1*
14.	*(a) Write a program in 8086 to convert a BCD number to its ASCII code equivalent.* *(b) Write a program in 8086 to convert a BCD number to its grey code equivalent.*	*2*
15.	*Write an ALP for traffic light controller using 8085.*	*1*
16.	*Write an ALP for interfacing of PPI 8255 with microprocessor 8085.*	*1*
17.	*A data string of no. of bytes is converted to its equivalent 2's complement using 8086 string instruction.*	*1*
	Total	***22***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Ramesh Gaonkar**, "Microprocessor Architecture, Programming, and Applications with the 8085**", Penram International Publication (India) Pvt. Ltd.*	*6th*	*2013.*
2.	*A. K. Ray & K. M. Bhurchandi, "**Advanced Microprocessors and peripherals**", Tata McGraw Hill*	*3rd*	*2012*
	Reference Books		
1.	*Douglas V. Hall**, "Microprocessors and Interfacing**", Tata McGraw Hill*	*3rd*	*2012*
2.	*Barry B. Brey, "**The Intel Microprocessors Architecture Programming and interfacing**", Pearson*	*8th*	*2012*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 441***		***Course Title***	***Semiconductor Devices and Technology***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the vital concepts and essential characteristics pertaining to intrinsic and extrinsic semiconductors.* ***CO2: Understand*** *the capacitive properties of semiconductor devices, and rectification effects of diodes.* ***CO3: Explain*** *the switching characteristics and delay time definition of Bipolar Junction Transistor.* ***CO4: Learn*** *conceptual understanding of physical characteristics of Field Effect Transistors.* ***CO5: Analyze*** *the power amplification in various class of amplifiers, and application of several optical semiconducting devices.* ***CO6: Apply*** *the knowledge of semiconductor properties, and theoretical and practical implementation of various devices.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Semiconductor Physics, Carrier Modelling and Carrier Action:*** *Energy Bands and Charge Carriers in Semiconductors: E-k diagram, Charge carrier concentration; Intrinsic carrier concentration; mass action law; Carrier transportation: Drift, diffusion and tunnelling, recombination, surface effects; Continuity equation in steady state condition; Fermi level; quasi-Fermi energy level; Hall effect; Optical and thermal properties.*	*8*
2.	***Unit 2: Classical diodes:*** *Shockley equation; Junction capacitance; Diffusion capacitance; Varactor diode; Tunnel diode; IMPATT diode; Gunn diode; Difference between rectifying contact and ohmic contact; Schottky Diode.*	*7*
3.	***Unit 3: Physics of Operation of BJT:***	*8*

	Transistor as switch, Delay time, Rise time, Storage time, Fall time, Transit frequency (wr); Ebers moll model; Gummel Poon model; Amplifier; RC coupled amplifier.	
4.	***Unit 4: Physics of FET:*** *JFET, Ohmic or triode region of operation, Saturation region of operation, Transfer characteristics, Output characteristics (Depletion Type Device or Normally-On device), Shockley Equation, Different parameters; MOS structure: Band diagram of an ideal MOS structure, Flat-band voltage, Region of operation, C-V characteristics; MOSFET: Region of operation, Transfer characteristics and Output characteristics for both n and p channel MOSFET (Enhancement and Depletion), Threshold voltage, body effect and channel length modulation, short channel effects, gradual channel approximation, Common source, Common gate and Common drain configurations.*	*12*
5.	***Unit 5: Power Amplifiers, Power Devices & Display Devices:*** *Power amplifiers with applications: Class A, Class B / push-pull, Class AB / complementary symmetry and Class C, SCR; Diac; Triac; Power BJT- Power MOSFET, Direct and Indirect semiconductor: LED, Solar cell, Photodiode, LCD, Opto Coupler, CCD and its applications.*	*10*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*D. A. Neamen, "**Semiconductor Physics and Devices**", McGraw Hill.*	*3rd*	*2003*
2.	*Sedra and Smith, "**Microelectronics Circuits: Analysis and design**", Oxford University Press.*	*6th*	*2013*
	Reference Books		
1.	*Jacob Millmann, C. C Halkias, Satyabrata Jit **"Electronics Devices and Circuits"**, TMH.*	*4th*	*2015*
2.	*Adir Bar-Lev, "**Semiconductor and Electronics Devices**", Prentice-Hall.*	*3rd*	*1993*
3.	*Ben G. Streetman and Sanjay Kumar Banerjee, "**Solid State Electronics Devices**", PHI Learning.*	*7th*	*2018*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 442***		***Course Title***	***Basics of Nanotechnology***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Physics and Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *the concepts of crystal structure and emerging world of nanoscience.* ***CO2: Understand*** *carbon based nanoelectronics devices and various approaches for nano-material.* ***CO3: Apply*** *the acquired knowledge to develop novel nanomaterials.* ***CO4: Analyze*** *the properties of different nanostructured materials.* ***CO5: Evaluate*** *the performance of nanotechnology related devices for various industrial applications.* ***CO6: Apply*** *the knowledge in developing Nano-Engineering Devices and Nano- Medicine.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Crystal Structure:*** *Crystalline structure of solid, Unit cells and space lattices, crystal structures, crystal plane and directions, Miller indices, diffraction of X-ray by crystal, Bragg's equation, crystal defects.*	*10*
2.	***Unit 2: Background of Nanotechnology:*** *Scientific revolution, molecular and atomic size, Importance of nanoscale, emergence of Nanotechnology, Challenges in Nanotechnology, Carbon age: (new forms of carbon graphene sheet to CNT).*	*9*
3.	***Unit 3: Approaches of Nanotechnology:*** *Macroscopic to microscopic crystals and nanocrystals, large surface to volume ratio, top-down and bottom-up approaches, self-assembly process, grain boundary volume in nanocrystals, defects in nanocrystals, surface effects on the properties.*	*9*
4.	***Unit 4: Nano materials and properties:***	*8*

	Types of Nanostructure: one dimensional (ID), two dimensional (2D), three dimensional (3D) Nanostructured materials, Quantum dots, Quantum wire, Quantum sheet structures, Allotropes of carbon, Graphene, Fullerenes, Carbon Nanotubes (CNTs).	
5.	***Unit 5: Applications of Nanomaterials:*** *Basic of nano electronics, Nanowires, Nano pore, Nano-circuits, Quantum electronic devices, CNT based transistor and Field Emission Display, biological applications, Biochemical sensor, Membrane based water purification, Medical application of nanomaterials.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Shunri Oda, David Ferry, "**Nanoscale Silicon Devices**", CRC Press, Taylor & Francis Group*	*1st*	*2016*
2.	*Robert Puers, "**Nanoelectronics: Materials, Devices, Applications**", Wiley*	*1st*	*2017*
	Reference Books		
1.	*Suprio Datta, "**Lessons from nanoelectronics**", World Scientific publisher*	*1st*	*2012*
2.	*C. N. R. Rao, H.C. Mult. Achim Müller,A. K. Cheetham, "**The Chemistry of Nanomaterials: Synthesis, Properties and Applications**" Wiley-VCH Verlag GmbH & Co. KGaA*	*1st*	*2004*
3.	*M.Wilson, K.Kannangara, G.Smith,"**Nanotechnology: Basic science and emerging technologies**", CRC Press, Taylor & Francis Group, Chapman & Hall*	*1st*	*2002*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 491***		***Course Title***	***Sensors and Signal Conditioning***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/ 201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the basics of measurement system.* ***CO2: Understand*** *different sensors based on their functionality.* ***CO3: Apply*** *sensors and signal conditioning system in electronic devices.* ***CO4: Analyse*** *different op-amp based instrumentation.* ***CO5: Assess and evaluate*** *suitable signal conditioning circuits for sensors.* ***CO6: Analyse*** *signal conditioning systems for different sensors.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Sensor-Based Measurement System:*** *Sensor classification, Input-output configuration: Interfering and modifying inputs, Configuration techniques, Static characteristics: of measurement system, Accuracy, Precision and sensitivity, Linearity and resolution, Systematic errors, Dynamic characteristics: Zero-order, First order and second order measurement.*	*9*
2.	***Unit 2: Sensors:*** *Temperature sensors, Flow sensors, Pressure sensors, Level sensors, Force sensors, Torque sensors, Acceleration sensors, Velocity sensors, Materials for sensors: Conductors, Semiconductors, Dielectrics, Magnetic materials.*	*9*
3.	***Unit 3: Interfacing of Sensors and Signal Conditioning:*** *Change of bios and level of signals, Loading effects on sensor's output, Potential divider, Low-pass RC filter, High-pass RC filter, Band pass filter, Band rejection filter.*	*9*
4.	***Unit 4: Op-amp based Instrumentation:***	*9*

	Instrumentation amplifiers, Instrumentation applications, Transducer bridge amplifiers, Op-amp in bridge circuit, Amplifying and linearization of bridge outputs, Bridge Signal conditioning, Bridge circuit in sensors, driving remote bridge, High impedance sensors using Op-amp.	
5.	***Unit 5: Active Filters:*** *Transfer function, First order active filters, Standard second order responses, KRC filters, Multiple feedback filters, Sensitivity, Filter approximations, Cascade design, Direct design, Switched capacitor, Switched capacitor filter.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Ramon-Pallas Areny and John G. Webster, "**Sensors and Signal Conditioning**", John Wiley & Sons Ltd*	*2nd*	*2001*
2.	*Franco S., "**Design with Operational Amplifiers and Analog Integrated Circuits**", McGraw Hill International Edition.*	*3rd*	*2002*
	Reference Books		
1.	*E.O. Doebelin and D.N. Manic, "**Measurement Systems: Applications and Design**", McGraw Hill.*	*5th*	*2007*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 451***		***Course Title***	***Introduction to Robotics***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***		***0***
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Four***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Retrieve*** *the history, concepts, and key components of robotics technology.* ***CO2: Understand*** *the control systems related to robotics.* ***CO3: Model*** *and control single joint robot.* ***CO4: Understand*** *various robot sensors, end effectors and their perception principles.* ***CO5: Analyse*** *the robot kinematics, navigation, and path planning.* *CO6:* ***Understand*** *machine vision and its digitizing function.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Fundamentals of Robotics:*** *Brief history of robotics, Robotics market, Future perspectives of robotics, robot anatomy, Robot drive systems, Precision of movement, End effectors.*	*8*
2.	***Unit 2: Control System and Components:*** *Basic control system concepts and model, Controllers, Robot sensors and actuators, Velocity sensors, Power transmission system, Modelling and control of single joint robot.*	*9*
3.	***Unit 3: Robot End Effectors and Sensors:*** *Types of end effectors, Mechanical grippers, other types of grippers, Robot/end effectors interface, Transducers, and sensors.*	*12*
4.	***Unit 4: Robot Motion Analysis and Control:*** *Introduction to manipulator kinematics, Homogeneous transformation, Robot kinematics, Manipulator path control, Robot dynamics.*	*8*

5.	***Unit 5: Machine Vision:*** *Introduction to machine vision, Sensing and digitizing function in machine vision, Image processing and analysis*	*8*
	Total	***45***

11.Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*M P Groover, "**Industrial Robotics**", TMH.*	*2nd*	*2012*
2.	*S R Deb and Sankha Deb**, "Robotics Technology and Flexible Automation**", TMH.*	*2nd*	*2010*
	Reference Books		
1.	*S.K Saha, "**Introduction to Robotics**", TMH.*	*2nd*	*2014*
2.	*R.K. Mittal, I. J. Nagrath, "**Robotics & Control**", TMH.*	*1st*	*2005*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 501***		***Course Title***	***Digital Signal Processing***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Signals and Systems (TEC304)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *discrete time signals & systems and various transforms.* ***CO2: Analyse*** *and* ***evaluate*** *the DFT and FFT algorithm.* ***CO3: Evaluate*** *the implementation of digital filter structures.* ***CO4: Apply*** *the design methods of IIR digital filter.* ***CO5: Analyse*** *and* ***apply*** *design techniques of FIR digital filters.* ***CO6: Integrate*** *the knowledge in designing of various digital signal processing-based systems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction of Discrete –Time Signals and Systems and other Transforms:*** *Elements of Digital Signal Processor, Discrete time sinusoids properties, Cross and Auto correlation, Z transform and its properties, ROC properties, Inverse Z transform. Introduction to Discrete time Fourier series (DTFS) and Discrete time Fourier transform (DTFT) and their properties.*	*8*
2.	***Unit 2: DFT and FFT Algorithms:*** *Discrete Fourier Transform (DFT), DFT as linear transformation, DFT properties, Circular convolution, Fast Fourier Transform (FFT): Decimation –in- Time Fast Fourier Transform (DITFFT), Decimation –in- Frequency Fast Fourier Transform (DIFFFT), Applications of FFT.*	*10*
3.	***Unit 3: Structures of Digital Filters:***	*9*

	Structure for realization of digital filters: Direct form I, Direct form II, Cascade and parallel Form, Transversal structure linear phase FIR filter structure.	
4.	***Unit 4: Design of Infinite Impulse Response (IIR) Digital Filters:*** *Design of IIR digital filters using impulse invariance technique, Bilinear transformation technique, Approximation of derivatives technique, Design of low pass Butterworth filter and Chebyshev filter.*	*10*
5.	***Unit 5: Design of Finite Impulse Response (FIR) Digital Filters:*** *Symmetric and anti-symmetric FIR filters, Linear phase FIR filters, Design of FIR filter using window techniques- Hamming, Hanning and Blackman, Rectangle, Bartlett and Kaiser windows, Effect of finite word length, Fixed point and binary floating point number representations.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*J. G. Proakis, D.G. Manolakis and D. Sharma, "**Digital Signal Processing Principles, Algorithms and Applications**", Pearson Education.*	*4th*	*2006*
2.	*Oppenhiem V.A.V and Schaffer R.W, "**Discrete – time Signal Processing**", Prentice Hall, New Jersey, US.*	*3rd*	*2013.*
	Reference Books		
1.	*S.K.Mitra, "**Digital Signal Processing**", TMH, New Delhi, India.*	*4th*	*2013*
2.	*Emmanuel C. Ifeachor, "**Digital Signal Processing A Practical Approach**", Prentice Hall, New Jersey, US.*	*2nd*	*2011*
3.	*S. Salivahanan, A. Vallavaraj and C. Gnanapriya, "**Digital Signal Processing - A Practical approach**", McGraw - Hill, New Delhi.*	*1st*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 502***		***Course Title***	***Communication Systems II***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Signals and Systems (TEC304), Communication Systems I (TEC 401)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Demonstrate*** *the concepts of sampling, Quantization and various waveform coding schemes.* ***CO2: Analyse*** *the effect of ISI and their mitigation.* ***CO3: Design and develop*** *different digital modulation systems.* ***CO4: Describe*** *the mathematical model of a digital modulation technique, characterize the effect of AWGN channel and determine its bit error rate performance.* ***CO5: Apply*** *the concepts of information theory for digital communication systems.* ***CO6: Apply*** *the concepts of digital communications for reliable communication with high data rate.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Sampling and Baseband Transmission:*** *Model of digital communication system, Sampling of low pass and band pass signals, Distortion due to sampling, Uniform and non-uniform quantization, Quantization error, Companding (A law and μ law), Pulse code modulation, Differential PCM, delta modulation, and adaptive delta modulation, Linear prediction filters.*	*10*
2.	***Unit 2: Digital Transmission through Band Limited AWGN Channels:*** *Representation of line codes – Properties and applications of line codes, Power spectral density of NRZ & RZ unipolar format, NRZ & RZ polar format, NRZ & RZ bipolar format, and Manchester format, Intersymbol interference, Nyquist criterion for Distortion-less baseband binary transmission, Raised cosine filter, Introduction to equalization techniques and Zero forcing equalizer.*	*9*

3.	***Unit 3: Digital Modulation Techniques:*** *Representation of bandpass signals and systems, Gram Schmidt procedures, Representation of digitally modulated signals; Amplitude shift keying, Phase shift keying, Differential PSK, Quadrature PSK, Frequency shift keying, Minimum shift keying.*	*8*
4.	***Unit 4: Optimum Receivers for AWGN Channel:*** *Model for received signal passed through an AWGN channel, Matched filter receiver and correlation receiver, Detector, Probability of error calculation for BASK, BPSK, QPSK, BFSK..*	*9*
5.	***Unit 5: Information Theory and Error Control Coding:*** *Information measure; Entropy and information rate, Discrete memory less source, Mutual information, Binary symmetric channel, Discrete channel capacity, Continuous information source, Continuous channel capacity, Source coding theorem, Shannon-Fano coding, Huffman coding, Channel capacity theorem.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*J Simon Haykin, "**Digital Communications**", John Wiley, India.*	*4th*	*2001*
2.	*Herbert Taub and Donald L Schilling, "**Principles of Communication Systems**", Tata McGraw Hill.*	*4th*	*2012*
3.	*B. P. Lathi and Z. Ding, "**Modern Digital and Analog Communication Systems**", Oxford University Press*	*4th*	*2009*
	Reference Books		
1.	*John.G. Proakis, "**Digital Communication**", Pearson Education, India.*	*5th*	*2014*
2.	*Bernard Sklar, "**Digital Communications: Fundamentals and Applications**", Prentice Hall, New Jersey, US.*	*2nd*	*2016*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 503***		***Course Title***	***Microcontroller and Embedded System***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/ PCC***					
8.	***Pre-requisite***	***Microprocessor and its applications (TEC 403)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *the concept of microcontroller.* ***CO2: Understand*** *the concepts of embedded systems using 8051 and Arduino IDE.* ***CO3: Apply*** *the concepts of interfacing of 8051 and Arduino to peripheral device, sensors and motors.* ***CO4: Examine*** *the applications of 8051 microcontroller and Arduino as I/O, timer and counter.* ***CO5: Evaluate*** *different tasks using assembly language programming for 8051 and C programming for Arduino.* ***CO6: Develop*** *foundation for the designing of Advanced embedded systems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***UNIT 1: Microcontrollers:*** *Difference between microprocessors and microcontrollers, Types of Micro-controllers, ARM processor, Memory structure of 8051, Processor architecture – Harvard v/s Von Neumann, CISC v/s RISC, 8051 architecture, control storage, Variable area, Stack, Hardware register space, SFR, 8051 pin diagram.*	*10*
2.	***Unit 2: 8051 Instruction Set:*** *Addressing modes, External addressing, Instruction execution, Instruction set – data movement, Arithmetic, Bit operators, Branch, Software development tools like assemblers, Simulators, O/P file formats. Assembling and running an 8051 program, 8051 data types, 8051 flag bits and the PSW register, 8051 register banks and stack.*	*10*
3.	***Unit 3: Programming of 8051 and Interrupts:***	*8*

	Programming of 8051, I/O bit manipulation. Timer, Counter, Programming of timer, 8051 interrupts, Interrupts priority in the 8051, and interrupts programming.	
4.	***Unit 4: Introduction to Arduino IDE Platform:*** *Introduction to ATMEGA328 microcontroller and Arduino IDE, Instruction set, Hardware, characteristics, Interfacing with different peripheral devices, PWM I/O pins, Interfacing Arduino hardware with internet of things.*	*9*
5.	***Unit 5: Interfacing:*** *Interfacing with 8051: 8255 (PPI), LCD, Keyboard, ADC, DAC interfacing, Sensor interfacing and signal conditioning, Stepper motor and DC motor, Basics of serial communications.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "**The 8051 Microcontrollers & Embedded Systems**", Pearson Education.*	*2nd*	*2014*
2.	*V Udayashankara, M S Mallikarjunaswamy, "**8051 Micro-controller, Hardware, Software and Application**", Tata McGraw-Hill education.*	*1st*	*2009*
3.	*Simon Monk, "**Programming Arduino: Getting Started with Sketches**", McGraw-Hill education.*	*2nd*	*2016*
	Reference Books		
1.	*Kenneth Ayala, "**The 8051 Microcontroller**", West Publishing Company.*	*3rd*	*2007*
2.	*Julien Bayle, "**C-Programming for Arduino**", Packt Publishing.*	*1st*	*2013*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 504***		***Course Title***	***Antenna and Wave Propagation***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/ PCC***					
8.	***Pre-requisite***	***Electromagnetic Field Theory (TEC 404)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the concept of radiation.* ***CO2: Compute*** *fundamental parameters of antenna and different antenna characteristics.* ***CO3: Analyse*** *uniform and non-uniform antenna array.* ***CO4: Evaluate*** *fundamental parameters for designing of microstrip patch antenna.* ***CO5: Develop*** *the concepts of wave propagation through free space.* ***CO6: Design*** *antenna for different application.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Radiation Fundamentals:*** *Potential theory, Helmholtz integrals, Radiation from a current element, Basic antenna parameters, Radiation field of an arbitrary current distribution, small loop antennas.*	*9*
2.	***Unit 2: Receiving Antenna:*** *Reciprocity relations, receiving cross section, and its relation to gain, Reception of completely polarized waves, Linear antennas, Current distribution, Radiation field of a thin dipole, Folded dipole, Feeding methods, Radiation from helical antenna.*	*10*
3.	***Unit 3: Antenna Arrays:*** *Array factorization. Array parameters. Broad side and end fire arrays. Yagi-Uda arrays Log-Periodic arrays, Broadband antennas, Helical antenna, Spiral antenna.*	*9*
4.	***Unit 4: Aperture Antennas:***	*9*

	Fields as sources of radiation, Horn antennas, Babinet's principle, Parabolic reflector antenna, Feeding systems, Microstrip antennas, Metamaterial antenna.	
5.	***Unit 5: Wave Propagation:*** *Propagation in free space, Propagation around the earth, Surface wave propagation, Structure of the ionosphere, Propagation of plane waves in ionized medium, Determination of critical frequency, MUF, Fading, Troposphere propagation, Super refraction.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*J. D. Kraus, R. Marhefka, A. Khan, "**Antennas and Wave Propagation**", McGraw Hill Education*	*4th*	*2017*
2.	*C. A. Balanis, "**Antenna analysis & Design**", John Wiley*	*3rd*	*2016*
3.	*R. E. Collin, "**Antennas and Radio Wave Propagation**", McGraw–Hill*	*1st*	*2013*
	Reference Books		
1.	*A. R. Harish and M. Sachidananda, "**Antennas and Wave Propagation**", Oxford Publication*	*1st*	*2017*
2.	*Joe Myers, "**Structure and Applications of Microstrip Antennas**", Clanrye International Publication,*	*1st*	*2015*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 501***		***Course Title***	***Digital Signal Processing Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Signals and Systems (TEC 304)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand,*** *implement, and analyse various basic signal convolution and correlation functions using MATLAB software.* ***CO2: Analyse*** *and* ***evaluate*** *DFT and IDFT functions through MATLAB software.* ***CO3: Analyse*** *and* ***evaluate*** *FFT algorithm through MATLAB software.* ***CO4: Analyse*** *and* ***evaluate*** *FIR and IIR digital filter through MATLAB software****.***

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Generation of various signals functions (Unit impulse, Unit step, Unit ramp signals, Sinc & Signum) through MATLAB.*	*2*
2.	*Sampling theorem verification using MATLAB..*	*2*
3.	*Write a MATLAB program to plot the power spectral density (PSD) of signal.*	*2*
4.	*Write a MATLAB program to plot the energy spectral density (ESD) of signal.*	*2*
5.	*Write a MATLAB program to generate and plot the real, imaginary, magnitude and phase part of given imaginary exponential function.*	*2*
6.	*To convolve sequence (i) linear (ii) circular, and their characteristics using MATLAB. (By given problems, verify it by mathematically as well as experimental ways).*	*2*
7.	*Sequences Correlation using MATLAB. (By given problems, verify it by mathematically as well as experimental ways and plot them).*	*2*
8.	*DFT and IDFT computation for a N point sequence using MATLAB.*	*2*
9.	*Development of FFT algorithm using MATLAB, validate the result through mathematically as well as experimentally.*	*2*
10.	*Generation of Gaussian distributed numbers using MATLAB.*	*2*

11.	*To simulate 2nd order IIR Filter using MATLAB.*	*2*
12.	*To simulate and design FIR filter using MATLAB.*	*2*
	Total	***24***
Innovative Experiments		
13.	*Circular Convolution of two Sequences by using FFT method.*	*2*
14.	*Write a MATLAB Program to implement Radix-2 Decimation in Time (DIT) FFT algorithm.*	*2*
	Total	***4***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Holly Moore, "**MATLAB for Engineers**", Pearson Education, Limited*	*2nd*	*2014*
	Reference Books		
1.	*Stephen J. Chapman, "**MATLAB Programming for Engineers**", Thompson*	*4th*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 502***		***Course Title***	***Communication Systems-II Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESS***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Basics of DSO and MATLAB***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Develop*** *and* ***understand*** *the signal sampling, quantization, and its reconstruction* ***CO2: Develop*** *an ability to* ***understand*** *and* ***design*** *various waveform coding techniques.* ***CO3: Develop*** *an ability to* ***evaluate*** *and* ***design*** *various digital modulation techniques.* ***CO4: Develop*** *an ability to* ***evaluate*** *and* ***design*** *Time Division Multiplexing technique.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Sampling of the signal using different sampling techniques and reconstruction of the sampled signals.*	*2*
2.	*Generation and detection of pulse code modulation technique.*	*2*
3.	*Generation and detection of Delta demodulator technique.*	*2*
4.	*To demonstrate Time division multiplexing & de-multiplexing process.*	*2*
5.	*Mapping of binary data into baseband pulses using different data formatting techniques.*	*2*
6.	*Mapping of binary data into passband signal using binary amplitude shift keying (BASK).*	*2*
7.	*Mapping of binary data into passband signal using binary frequency shift keying (BFSK).*	*2*
8.	*Mapping of binary data into passband signal using binary phase shift keying (BPSK).*	*2*
9.	*Simulation of binary amplitude shift keying (BASK) modulated Signal using MATLAB*	*2*
10.	*Simulation of binary frequency shift keying (BFSK) modulated signal using*	*2*

	MATLAB.	
11.	*Simulation of binary phase shift keying (BPSK) modulated signal using MATLAB.*	*2*
12.	*Simulation of differential phase shift keying (DPSK) using MATLAB.*	*2*
	Total	***24***
Innovative Experiments		
13.	*To plot and analyze the waveform for Quadrature Phase Shift Keying (QPSK) signal using MATLAB for a given bit stream.*	*2*
14.	*Simulation of QAM modulation and demodulation using MATLAB.*	*2*
15.	*Simulation of MSK modulation and demodulation using MATLAB.*	*2*
	Total	***6***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*B. P. Lathi, "**Modern Digital and Analog Communication**", Oxford Publication*	*3rd*	*2005*
2.	*Simon Haykin, "**Communication Systems**", John Willey.*	*4th*	*2001*
	Reference Books		
1.	*Proakis,John G., "**Digital Communication**", McGraw-Hill Inc.*	*3rd*	*1995*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 503***		***Course Title***	***Microcontroller & Embedded Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Microprocessor Lab (PEC-403)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *8051 microcontroller instruction set.* ***CO2: Understand*** *different assembly language programs on microcontroller-based microcomputer kit.* ***CO3: Apply*** *the programming concepts to test and debug assembly language programs in the laboratory.* ***CO4: Assemble*** *various devices and memory with microcontroller for any defined task.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*a) Write a program in 8051 to add two 8-bit numbers.* *b) Write a program in 8051 to subtract two 8-bit numbers.*	*2*
2.	*a) Write a program in 8051 to add two 16-bit numbers.* *b) Write a program in 8051 to subtract two 16-bit numbers.*	*2*
3.	*a) Write a program in 8051 to find the largest no. from an array of n numbers stored in an array.* *b) Write a program in 8051 to find smallest no. from an array of n numbers stored*	*2*
4.	*Write a program in 8051 to add two 8-bit BCD numbers.*	*2*
5.	*a) Write a program in 8051 to multiply two 8-bit data.* *b) Write a program in 8051 to divide two 8-bit data.*	*2*
6.	*Write a program in 8051 to convert a BCD number to its ASCII code equivalent.*	*1*
7.	*Write a program in 8051 which move a block of data.*	*1*
8.	*Write a program in 8051 which sort a block of data.*	*1*
9.	*Write a program in 8051 which convert a binary number to its grey code*	*1*

	equivalent	
10.	*Write a program in 8051 which determines average of n numbers.*	*1*
11.	*Write a program in 8051 to convert a BCD number to its binary code equivalent*	*1*
12.	*Write a program in Arduino to use PWM pin to increase and decrease the intensity of brightness in an LED.*	*2*
13.	*Write a program in Arduino to interface LED and create a burglar alarm.*	*2*
14.	*Write a program in Arduino to interface with a dc motor.*	*2*
	Total	***22***
Innovative Experiments		
1.	*PPI 8255 Interface to 8051.*	*2*
2.	*Traffic Light Controller interface to 8051.*	*1*
3..	*Interfacing Arduino IDE to create an IoT data log.*	*1*
	Total	***4***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "**The 8051 Microcontrollers & Embedded Systems**", Pearson Education*	*2nd*	*2014.*
2.	*V Udayashankara, M S Mallikarjuna Swamy, "**8051 Micro-controller, Hardware, Software and Application**", Tata McGraw-Hill education*	*1st*	*2009.*
3.	*Simon Monk, "**Programming Arduino: Getting Started with Sketches**", McGraw-Hill education*	*2nd*	*2016.*
	Reference Books		
1.	*Kenneth Ayala, "**The 8051 Microcontroller**", West Publishing Company*	*3rd*	*2007*
2.	*Julien Bayle, "**C-Programming for Arduino**", Packt Publishing*	*1st*	*2013*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 542***		***Course Title***	***Electromagnetic Interference and Compatibility***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Electromagnetic Field Theory(TEC404)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the concepts of electromagnetic interference.* ***CO2: Analyse*** *the measurement techniques of electromagnetic interference.* ***CO3: Differentiate*** *among various EMC standards.* ***CO4: Examine*** *EMI control and filtering.* ***CO5: Investigate*** *EMC design and interconnection.* ***CO6: Design*** *and develop different EMC techniques.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Basic Concept:*** *Definition of EMI and EMC, Classification of EMI/EMC - CE, RE, CS, RS, Units of parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD phenomena and effects, Transient phenomena and suppression.*	*10*
2.	***Unit 2: EMI Measurement****:* *Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, Current probe, EMC Analyzer and detection Technique open area site, Shielded anechoic chamber, TEM cell.*	*9*
3.	***Unit 3: EMC Standard and Regularization:*** *National and intertional standardizing organizations, FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE And RE standards, CISPR, CE and RE standards, IEC/EN, CS standards, Frequency assignment - Spectrum conversation.*	*9*

4.	***Unit 4: EMI Control and Method Fixes:*** *Shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, Opto-isolator.*	*8*
5.	***Unit 5: EMC Design and Interconnection Technique:*** *Cable routing and connection, Component selection and mounting, PCB Design- Trace routing, Impedance control, Decoupling, Zoning and grounding.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*H. W. Ott, "**Electromagnetic Compatibility Engineering**", Wiley.*	*1st*	*2009*
2.	*C. R. Paul**, "Introduction to Electromagnetic compatibility"**, Wiley.*	*2nd*	*2010*
	Reference Books		
1.	*D. G. Baker**, "Electromagnetic Compatibility: Analysis and Case Studies in Transportation"**, Wiley.*	*1st*	*2014*
2.	*D. A. Weston, "**Electromagnetic Compatibility: Principles and Applications**", Marcel Dekker Inc.*	*1st*	*1991*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 543***		***Course Title***	***High Speed Communication Circuits***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***SEE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Electronics Devices and Circuits ((TEC 301), Analog Integrated Circuits (TEC 402), and Communication Systems I (TEC 401)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Identify*** *the concepts of RF design and different communication transceiver modules.* ***CO2: Understand*** *LNA and mixer implementation.* ***CO3: Discuss*** *power amplifiers it's efficiency.* ***CO4: Implement*** *circuits for phase locked loop.* ***CO5: Analyse*** *the application of frequency synthesizers.* ***CO6: Design*** *various high-speed communication systems for wireless applications.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Noise in Communication Subsystems:*** *Internal and external noise, Noise in resistors, Noise sources in a CMOS amplifier, Broadband amplifier design, Considerations for noise, Narrowband amplifier Noise requirements, Cascaded amplifiers noise performance.*	*9*
2.	***Unit 2: LNA Design:*** *LNA topologies, LNA noise factor and noise figure, Narrowband LNA Design for wireless systems, Direct input termination of CS Amplifier, Noise Factor analysis of CS amplifier, Noise factor Analysis of CG amplifier, Inductor degenerated CS amplifier, Derive noise factor for inductor degenerated amplifier.*	*8*
3.	***Unit 3: Power Amplifiers:*** *Resistor loaded class A amplifier, Class A RF power amplifier, Class B power amplifier, Push-Pull amplifier, Class C amplifier, Class D power amplifier, Class D Push-Pull power amplifier, Class B vs. D Push-Pull amplifier waveforms.*	*8*

4.	***Unit 4: VCO and Mixers:*** *Voltage Controlled Oscillators (VCO's), Model for voltage to frequency mapping of VCO, Model for voltage to phase mapping of VCO, frequency domain model of VCO, Recently popular approach – The MOS varactor, Method to increase Q of MOS varactor, Boosted VCO, Very high frequency VCO, Mixer design for wireless systems, Ideal mixer behaviour, Issue of image aliasing.*	*10*
5.	***Unit 5: Overview of Phase-Locked Loops and Integer-N Frequency Synthesizers:*** *Phase-locked loop, Method of phase detection, Impact of changes in phase error, Integer-N frequency synthesizer, Integer-N frequency synthesizers in wireless systems, Key limitation of integer-N synthesizers, Fractional-N frequency synthesis, Classical fractional-N synthesizer architecture, Accumulator operation, Phase interpolation technique.*	*10*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*J. Smith, "**Modern Communication Circuits**", McGraw – Hill*	*2nd*	*1997*
2.	*Lee, Thomas H. "**The Design of CMOS Radio-Frequency Integrated Circuits**", Cambridge, UK: Cambridge University Press*	*2nd*	*1997*
	Reference Books		
1.	*T. H. Lee, "**The Design of CMOS Radio – Frequency Integrated Circuits**" Cambridge*	*2nd*	*2004*
2.	*J. S. Beasley & G. M. Miller, "**Modern Electronic Communication**", Pearson.*	*9th*	*2005*
3.	*T.L. Floyd, "**Electronic Devices**", Pearson.*	*7th*	*2007*
4.	*Razavi, Behzad, "**RF Microelectronics**", Upper Saddle River, NJ: Prentice Hall.*	*2nd*	*1997*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 591***		***Course Title***	***Transducers, Actuators and Display Devices***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/ TEC 201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the basic concepts of sensor's characteristics and its physical effect.* ***CO2: Understand*** *the concepts of different transducers.* ***CO3: Apply*** *the concepts in the designing of various MEMS actuators.* ***CO4: Analyse*** *different optoelectronic devices.* ***CO5: Assess and evaluate*** *different types of display systems.* ***CO6: Use*** *transducers and optoelectronic devices for the development of electronic circuits.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Sensor Characteristics and Physical Effects:*** *Active and passive sensors, Static and dynamic characteristics, Accuracy, offset and linearity, Physical effects involved in signal transduction, Photo-electric effect, Photoluminescence, Electroluminescence, chemiluminescence effect, Hall effect, Thermoelectric effect, Piezoresistive effect, Piezoelectric effect, Pyroelectric effect, Magneto-mechanical effect (magnetostriction), Magneto resistive effect.*	*10*
2.	***Unit 2: Transducers:*** *Conductometric and capacitive transducers, Interferometric optical transducer, Electrochemical transducer, PN diode-based transducer, Schottky diode-based transducer, BJT based transducers, FET based transducers, Cantilever-based transducers.*	*9*
3.	***Unit 3: MEMS Actuators and Sensors:*** *Electromechanical transducers: Piezoelectric transducers, Electro-strictive transducers, Magneto-strictive transducers, Electrostatic actuators, Electromagnetic transducers, Electrodynamic transducers, Electrothermal*	*9*

	actuators, Micro sensing for MEMS: Piezoresistive sensing, Capacitive sensing, Piezoelectric sensing.	
4.	***Unit 4: Optoelectronic Devices:*** *Solar radiation, Photovoltaic devices, PN homo junction solar cells, Antireflection coatings, Ideal conversion efficiency, Spectral response, I-V characteristics, Temperature and radiation effects, Heterojunction solar cells, Schottky barrier solar cell.*	*9*
5.	***Unit 5: Display Devices:*** *Characterization of displays, Drawbacks of cathode ray tube, Flat panel display: Electroluminescence displays, Plasma display, LED, LCD.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Kourosh Kalantar – Zadeh, Benjamin Fry, "**Nanotechnology-Enabled Sensors**", Springer Publication*	*1st*	*2008.*
	*Vijay K. Varadan, K. J. Vinoy and K. A. Jose, "**RF MEMS & Their Applications**", John Wiley & Sons*	*1st*	*2003.*
	Reference Books		
1.	*S. M. Sze, and K. K. Ng, "**Physics of Semiconductor Devices**", Wiley-Interscience*	*3rd*	*2006*
2.	*J. Wilson & JFB Hawkers, "**Optoelectronics: An introduction**", PHI*	*3rd*	*1998*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 551***		***Course Title***	***Sensor Technology***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Five***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Physics, Basic Electronics Engineering(TEC 101/201)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Develop*** *the knowledge about the basic characteristics of sensors.* ***CO2: Understand*** *the working principles of sensors.* ***CO3: Execute*** *sensors interfacing with various electronic device.* ***CO4: Apply*** *the concepts of sensor technology in several types of motion and displacement sensors.* ***CO5: Evaluate*** *sensors and interfacing circuits.* ***CO6: Utilize*** *sensors in different engineering applications.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Sensor Characteristics:*** *Transfer function, Calibration, Span (Full-scale input), Full-scale output, Calibration error, Accuracy, Hysteresis error, Nonlinearity, Saturation, Repeatability, Dead band, Resolution, Reliability, Uncertainty.*	*9*
2.	***Unit 2: Working principles of sensors:*** *Electric charges, Fields and potentials, Capacitance, Magnetism: Faraday law, Solenoid, Toroid, Induction Resistance, Piezoelectric effect, Pyroelectric effect, Hall effect, Thermoelectric effect, Sound waves, Temperature, Dynamic models of sensor elements, Optical components of sensor.*	*9*
3.	***Unit 3: Interface Electronic Circuits:*** *Input characteristics of interface circuits, Amplifiers, Light to voltage converters, Excitation circuits, Analog to digital converters, Noise in sensors: Inherent noise, Transmitted noise, Electric shielding, Bypass capacitors, Magnetic shielding, Mechanical noise, Ground planes, Seebeck noise*	*9*

4.	***Unit 4: Motion and Displacement Sensor:*** *Ultrasonic detectors, Optoelectronic motion detectors, Potentiometric sensors, Capacitive sensors, Inductive and magnetic sensor: LVDT, RVDT, Eddy current sensors, Transverse inductive sensor, Hall effect sensor.*	*9*
5.	***Unit 5: Humidity Sensors and Light Detectors:*** *Concept of humidity, Electrical conductivity sensors, Thermal conductivity sensor. Image sensors: CCD sensor, CMOS-Imaging sensor, Gas flame detectors.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Jacob Fraden, "**Handbook of modern sensors: physics, designs, and applications**", Springer*	*4th*	*2005*
	Reference Books		
1.	*C.M. Kyung, H. Yasuura, Y. Liu, Y. L. Lin, "**Smart Sensors, and Systems: Innovations for Medical, Environmental, and IoT Applications**", Springer*	*1st*	*2016*
2.	*Jon Wilson, "**Sensor Technology Handbook**", Elsevier*	*1st*	*2004*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 601***		***Course Title***	***Wireless Communication***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Communication Systems II (TEC 502)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Demonstrate*** *an understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards.* ***CO2: Demonstrate*** *an understanding on cellular concepts, cellular architecture, and evolution of different generations and standards for mobile cellular communication.* ***CO3: Analyse*** *and* ***design*** *of mobile radio propagation models.* ***CO4: Analyse*** *different channel parameters, causes of impairments in signal propagation and impairment removal techniques.* ***CO5: Analyse*** *different diversity combining techniques.* ***CO6: Apply*** *the concepts of spread spectrum for designing wireless communication systems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Wireless Communication System, Standards & Cellular Concept:*** *An overview of wireless communication, Basic elements in wireless communication systems, Wireless communication system, and standards. Evolution of mobile cellular communication (1G, 2G. 2.5G, 3G and beyond), Typical cellular standards (AMPS, GSM, GPRS, WCDMA, LTE, LTE-A). Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference & system capacity, Trunking & grade of service – Improving coverage and capacity in cellular system.*	*11*
2.	***Unit 2: Evolution of Mobile Radio Propagation Fundamentals: Large Scale Path Loss:*** *Introduction to radio wave propagation, Free space propagation model, Basic propagation mechanisms, Ground reflection (Two-Ray) Model, Indoor*	*7*

	propagation models, path loss model.	
3.	***Unit 3: Small Scale Fading & Multipath:*** *Small-scale multipath propagation, Impulse response model of multipath channel, Parameters influencing small scale fading, Types of small-scale fading, Diversity mechanisms.*	*10*
4.	***Unit 4: Diversity Combining Techniques:*** *Rayleigh &Rician fading models, Selection Combining (SC), Equal Gain Combining (EGC), and Maximal Ratio Combining (MRC), Derivation of SC, EGC, and MRC improvement, RAKE receiver.*	*10*
5.	***Unit 5: Spread spectrum:*** *Multiple access techniques, Pseudo-noise sequence, Direct sequence spread spectrum (DS-SS), Frequency hopped spread spectrum (FHSS). Time hopping.*	*7*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Sanjay Kumar, "**Wireless Communication: The Fundamental and Advanced Concepts**", River Publishers Series (Indian reprint).*	*1st*	*2015*
2.	*Rappaport, T.S., "**Wireless communications**", Pearson Education, India.*	*2nd*	*2012*
	*David Tse, Pramod Viswanath, "**Fundamentals of Wireless Communication**", Cambridge University Press.*	*1st*	*2005*
	Reference Books		
1.	*T L Singal, "**Wireless Communications**", Tata McGraw Hill Education India.*	*1st*	*2014*
2.	*Simon Haykin and Michael Moher, "**Modern Wireless Communications**", Parson Education.*	*2nd*	*2005*
3.	*Andrea Goldsmith, "**Wireless Communications**", Cambridge University Press.*	*1st*	*2005*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 602***		***Course Title***	***Microwave Engineering***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Communication Systems I(TEC 501), Communication Systems II (TEC 502), and Electromagnetic Field Theory(TEC 304)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *the basic concepts of waveguides and understanding of waveguides characteristics and cavity resonators.* ***CO2: Analyse*** *various microwave sources and their characteristics.* ***CO3: Apply*** *the basics of the waveguide to different microwave components based on network parameters.* ***CO4: Understand*** *various parameters measurement for evaluating the performance of the microwave components.* ***CO5: Implement*** *Microstrip filters used in RF transmitter and receiver.* ***CO6: Design*** *RF components, transmitter, receiver, and RF communication links.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Waveguides:*** *Introduction to waveguides. Rectangular and circular waveguide, Excitation of waveguides, Rectangular cavity resonators.*	*10*
2.	***Unit 2: Microwave Sources:*** *Limitations of Conventional Tubes, Two-cavity Klystron, Reflex Klystron, Magnetron (Conventional, linear), TWT, Gunn diode, IMPATT, TRAPATT, Tunnel diode –Operation & characteristics, Basics of GaAs FET.*	*09*
3.	***Unit 3: Passive Microwave Devices:*** *Network parameter of microwave circuit, Scattering matrix. Power divider, Microwave T junctions, E plane TEE, H plane TEE, Magic TEE, Attenuators & phase changers, Isolator & circulators, Directional couplers.*	*09*
4.	***Unit 4: Microwave Measurements:***	*09*

	Measurement of frequency, Wavelength, Power, VSWR, Impedance determination, S-Parameter measurements, Spectrum analyzer, Network analyzer.	
5.	***Unit 5: Microwave Systems:*** *Introduction to microstrip line. Types of filter designing, Low-pass prototype filter design, Filter transformations, Filter implementation, Richard transformation, Kuroda identities, Stepped-Impedance low pass filters.*	*08*
	Total	***45***

11. Suggested Books

SL. No.	*Name of Authors/Books/Publishers*	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*Samuel Liao, "**Microwave Devices & Circuits**", PHI*	*3rd*	*2003*
2.	*D M Pozar, "**Microwave Engineering**", John Wiley & Sons*	*4th*	*2013*
	Reference Books		
1.	*R E Collins**, "Foundations for Microwave Engineering**", John Wiley & Sons*	*2nd*	*2007*
2.	*I J Bhal and P. Bharti, "**Microwave Solid state Circuit Design**", John Wiley & Sons*	*2nd*	*2003*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 603***		***Course Title***	***VLSI Technology and Design***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Digital Electronics (TEC 302) and Electronics Devices and Circuits (TEC 301)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Develop*** *a basic understanding of VLSI fabrication technology.* ***CO2: Illustrate*** *different kind of diffusion and deposition techniques in VLSI.* ***CO3: Discuss*** *VLSI design concepts, MOS structure, and MOSFET equation in terms of current and voltage.* ***CO4: Examine*** *the properties and characteristics of MOS structures.* ***CO5: Understand*** *various layout and stick design of CMOS circuits.* ***CO6: Propose*** *the characteristic differences in MOS structures and device-based projects.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: VLSI Technology:*** *Clean room technology, Crystal growth and wafer preparation, electronic grade silicon, CZ crystal growth technique, and Silicon shaping. Epitaxy: Vapor-phase epitaxy, Doping and auto-doping, Buried layers. Oxidation: Importance, Deal and Grove's model.*	*9*
2.	***Unit 2: Diffusion:*** *Models of diffusion in solids, Fick's law. Ion implantation: Range theory, Ion stopping, Implantation equipment, Annealing. Lithography: Types, Photoresist. Etching: Wet etching, Ion milling, Liftoff. Metallization: Applications, Choices, Deposition.*	*9*
3.	***Unit 3: Era of VLSI Design:*** *Introduction to VLSI design, Front end and Back-end design, Computer-aided design technology.*	*9*

	MOS Transistor: *MOS structure, MOS system under external Bias, Threshold voltage, Structure and operation of MOS transistor, MOSFET device design equation, MOSFET scaling, MOSFET capacitances.*	
4.	***Unit 4: MOS Inverters:*** *Static characteristics, resistive–load inverter, Inverters with n-type MOSFET load, CMOS inverter, switching characteristics of MOS inverters, Delay-time definitions, Switching power dissipation of CMOS inverters.*	*10*
5.	***Unit 5: Layout Design:*** *Design rules, Stick diagram, Parasitic effects, Layout design prospects, CMOS basic circuits layout design: NAND, NOR, AND, OR, AOI circuits.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*S. Kang and Y. Leblebici**, "CMOS Digital Integrated Circuits, Analysis and Design**", Tata McGraw-Hill*	*3rd*	*2003*
2.	*S. M. Sze, "**VLSI Technology**", McGraw Hill,*	*2nd*	*1988*
3.	*James D. Plummer, Michael Deal, Peter D. Griffin, "**Silicon VLSI Technology: Fundamentals, Practice, and Modeling**", Pearson.*	*1st*	*2003*
4.	*Sorab K. Ghandi, "**VLSI Fabrication Principles Silicon And Gallium Arsenide", A Wiley Inderscience Publications.*	*2nd*	*1994*
	Reference Books		
1.	*D. A. Pucknell and K. Eshraghian, "**Basic VLSI Design**", Prentice-Hall of India.*	*3rd*	*1994*
2.	*Stephen A. Campbell, "**The Science and Engineering of Microelectronic Fabrication**", Oxford University Press.*	*2nd*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 601***		***Course Title***	***CAD of Electronics Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/LC***					
8.	***Pre-requisite***	***Digital Electronics Lab (PEC 302)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the concepts associated with different analog and digital electronics devices like MOSFETs, CMOS, logic gates etc.* ***CO2: Apply*** *the basics of these devices to analyse various electronic circuits like amplifier, inverter, adder, subtractor etc.* ***CO3: Analyse*** *different circuits (both DC and transient) using simulation tools.* ***CO4: Design*** *various analog and digital electronics circuit.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*Design and simulation of various gates.*	***2***
2.	*Design and simulation of XOR gate using NAND gate only.*	***2***
3.	*Design and simulation of the comparator.*	***2***
4.	*Design and simulation of full adder and full subtractor.*	***2***
5.	*Design and simulation of multiplexer and demultiplexer.*	***2***
6.	*Design and analysis (DC and Transient) of CMOS inverter using 0.18 µm technology.*	***2***
7.	*Design, simulation, and analysis of common source amplifier using 0.18 µm technology.*	***2***
8.	*Design, simulation and analysis of common drain amplifier using 0.18 µm technology.*	***2***

9.	*Design and comparison of DC and transient output characteristics of CMOS inverter at different aspect ratio.*	***2***
10.	*Layout design of CMOS inverter using 0.18 µm technology*	***2***
PART – B (using Xilinx Tool)		
11.	*Design, simulation and synthesis of various logic gates using Verilog HDL.*	***2***
12.	*Design, simulation and synthesis of full adder and full subtractor using Verilog HDL.*	***2***
13.	*Design, simulation and synthesis of multiplexer and de-multiplexer.*	***2***
	Total	***26***
Innovative Experiments		
1.	*Design, simulation and synthesis of Flip-Flops.*	***2***
2.	*Design and simulation of MOS differential amplifier using Cadence tool.*	***2***
3.	*Design and simulation of current mirror circuit using Cadence tool.*	***2***
	Total	***6***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*S. Kang and Y. Leblebici, "**CMOS Digital Integrated Circuits, Analysis and Design**", Tata McGraw-Hill*	*3rd*	*2003*
2.	*James D. Plummer, Michael Deal, Peter D. Griffin, "**Silicon VLSI Technology: Fundamentals, Practice, and Modeling**", Pearson.*	*1st*	*2003*
	Reference Books		
1.	*D. A. Pucknell and K. Eshraghian, "**Basic VLSI Design**", Prentice-Hall of India.*	*3rd*	*1994*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***PEC 602***		***Course Title***	***Microwave and Antenna Lab***		
2.	***Contact Hours***	***L***	***0***	***T***	***0***	***P***	***2***
3.	***Examination Duration***	***Theory***	***0***		***Practical***	***3***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***01***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/ LC***					
8.	***Pre-requisite***	***Electromagnetic Field Theory (TEC-404), Antenna and Wave Propagation (TEC-504)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *microwave bench and related components.* ***CO2: Apply*** *the fundamentals to measure the parameters of microwave and analyse S-parameters for various microwave devices.* ***CO3: Evaluate*** *and* ***measure*** *the necessary antenna performance parameters.* ***CO4: Develop*** *basic skills to learn some CAD tool and apply in the design of various antennas.*

10. Details of the Course

Sl. No.	***List of problems for which student should develop program and execute in the Laboratory***	***Contact Hours***
1.	*To measure the guide wavelength and frequency of the signal in a rectangular waveguide, working on TE_{10} mode.*	*2*
2.	*To draw the mode characteristic of reflex klystron.*	*2*
3.	*To measure the characteristics of given E plane, H plane and Magic TEE.*	*2*
4.	*To measure the characteristics of given circulator and directional coupler.*	*2*
5.	*Analyze the change in frequency and output power with the change in bias voltage of Gunn diode.*	*2*
6.	*To verify the characteristic of low pass filter using power sensor.*	*2*
7.	*To draw the polar pattern and measure the gain of waveguide Horn antenna.*	*2*
8.	*To study the characteristics of a patch antenna.*	*2*
9.	*To design and simulate a rectangular shape microstrip patch antenna with the given input parameters.*	*2*
10.	*To design and simulate a triangular shape microstrip patch antenna with the*	*2*

	given input parameters.	
11.	*To design and simulate a circular shape microstrip patch antenna with the given input parameters.*	*2*
12.	*To implement the optimization for the design of a patch antenna.*	*2*
13.	*To design and simulate a low pass filter with the given input parameters.*	*2*
14.	*Measure the characteristics of power divider and power combiner (S-Band and C-Band).*	*2*
	Total	***28***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Samuel Liao, "**Microwave Devices & Circuits**", PHI.*	*3rd*	*2003*
2.	*D M Pozar, "**Microwave Engineering**", John Wiley & sons.*	*4th*	*2013*
3.	*C. A. Balanis, "**Antenna analysis & Design**", John Wiley & sons.*	*3rd*	*2016*
	Reference Books		
1.	*Muhammad Kamran Khattak, "**Design and Simulation of Microstrip Antenna**", Lambert Academic Publishing*	*1st*	*2012*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 641***		***Course Title***	***Data Communication Networks***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Communication Systems I(TEC 401) & II (TEC 502)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Understanding*** *of OSI and TCP/IP network models and designing of physical layer.* ***CO2: Understanding*** *functions of data link layer and its protocols* ***CO3: Understanding*** *channel access techniques and IEEE LAN and MAN standards.* ***CO4: Analyzing*** *performance of routing protocols and understanding of congestion control techniques, IPV4, TCP.* ***CO5: Understanding*** *functions of presentation, session and application layer.* ***CO6: Successful*** *completion of this course will enable student to analyze the heterogeneous packet switched network.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Data Communication:*** *Goals and Applications of Networks, LAN, WAN, MAN, Wireless networks. Reference Model: OSI, TCP/IP. Physical Layer: Data and signals, digital transmission, analog transmission, Bandwidth utilization- multiplexing and spreading, Wireless transmission, Circuit switching, Packet switching.*	*8*
2.	***Unit 2: Data Link Layer:*** *Data link layer design issues, services provided to network layer, Framing, Error control, Flow control, Error detection and correction, Elementary data link protocols, unrestricted Simplex protocol, A Simplex Stop-and-Wait protocol, Simplex Protocol for a noisy channel, Sliding Window protocols, A protocol using go-back-N, A protocol using selective repeat, Example data link protocol-HDLC and PPP.*	*8*
3.	***Unit 3: Medium Access Control Sub layer:***	*9*

	Channel Allocations, Static and dynamic allocation in LAN, Multiple Access protocols, ALOHA, Carrier Sense multiple access protocols, Collision free protocols, Limited contention protocols, IEEE standard 802.3-Ethernet, IEEE standard 802.4- Token bus, IEEE standard 802.5-Token Ring, IEEE standard 802.6- FDDI, bridges.	
4.	***Unit 4: Network and Transport Layer:*** *Network Layer design issues, Concept of virtual circuit and datagram subnet, Routing algorithms, Congestion Control Algorithms, Internetworking, IP protocol and addressing. Transport services, Design issues, elements of transport protocols, simple transport protocols, Connection management, TCP, UDP.*	*8*
5.	***Unit 5: Presentation and Application Layer & Security:*** *Presentation Layer: Design issues, Data compression techniques, cryptography.* *Application Layer: Domain Name System (DNS), File Transfer (FTP), Access and Management, Electronic mail (SMTP), Virtual Terminals, Network Security: Security services, message confidentiality, integrity And Authentication.* *Integrated and differentiated services internet model, Multi-protocol label switching (MPLS).*	*12*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*A.S. Tanenbaum, "**Computer Networks**", Prentice Hall, India.*	*3rd*	*2010*
2.	*Behrouz A. Forouzan,, "**Data Communications and Networking**", TMH.*	*4th*	*2007*
	Reference Books		
1.	*S. Keshav, "**An Engineering Approach on Computer Networking**", Addison Wesley.*	*1st*	*2008*
2.	*W. Stallings, "**Data and Computer Communication**", Macmillan Press*	*8th*	*2009*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 642***		***Course Title***	***Digital VLSI Circuit Design***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Basic Electronics Engineering (TEC 101/201) and Digital Electronics (TEC 302)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Describe*** *the basic MOS structure and layout design* ***CO2: Understand*** *the static and dynamic characteristics of MOS inverters.* ***CO3: Apply*** *the MOS concepts to design combinational and sequential MOS logic circuits.* ***CO4****: **Analyse** different digital MOS logic circuits.* ***CO5: Estimate*** *power consumption of CMOS logic circuits.* ***CO6: Integrate*** *various concepts of digital VLSI circuit design and apply them in* ***designing*** *of MOS based digital circuits.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Review of MOS Technology:*** *MOS structure, MOS under external bias, MOSFET, Scaling of MOS circuits, Small geometry effects, MOSFET capacitances. MOS circuit design processes: MOS layers, Design rule: Stick diagram and layout.*	*10*
2.	***Unit 2: MOS Inverters:*** *Static characteristics: Introduction, Resistive-load inverter, Inverters with N-Type MOSFET load, CMOS inverter. Switching characteristics and interconnect effects: Introduction, Delay –time, Inverter design with delay constraints, Estimation of interconnect parasitic, Calculation of interconnect delay, Switching power dissipation of CMOS inverters.*	*11*
3.	***Unit 3: MOS Logic Circuits:*** *Combinational MOS logic circuits: MOS logic circuit with depletion NMOS loads, CMOS logic circuits, Complex logic circuits, CMOS transmission gates.*	*10*

	Sequential MOS logic circuits: Behaviour of bistable elements, SR latch, Clocked latch and Flip-flop, CMOS D- latch and Flip-flop.	
4.	***Unit 4: Dynamic Logic Circuits:*** *Basic principles of pass transistor circuits, Voltage bootstrapping, Synchronous dynamic circuit techniques, Dynamic CMOS circuit, High performance dynamic CMOS circuits.*	*7*
5.	***Unit 5: Low Power CMOS Logic Circuits:*** *Overview of power consumption, Low power design through voltage scaling, Estimation and optimization of switching activity, Reduction of switched capacitance, Adiabatic logic circuits.*	*7*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*S. Kang and Y. Leblebici, "**CMOS Digital Integrated Circuits, Analysis and Design**", Tata McGraw-Hill.*	*3rd*	*2003*
2.	*J. M. Rabaey, A. Chandrakasan and B. Nikolic, "**Digital Integrated Circuits: A Design Perspective**", Prentice-Hall of India.*	*1st*	*2006*
	Reference Books		
1.	***D. A. Pucknell and K. Eshraghian, "Basic VLSI Design",*** *Prentice-Hall of India*	*3rd*	*1994*
2.	*K. Eshraghian, D. A. Pucknell and S. Eshraghian, "**Essentials of VLSI Circuit and Syste**m", Prentice-Hall of India.*	*2nd*	*2005*
3.	*N. H. E. Weste and D. M. Harris, "**CMOS VLSI Design**", Pearson.*	*3rd*	*2005*
4.	*R. Jacob Baker, "**CMOS: circuit design, layout, and simulation**", John Wiley & Sons.*	*3rd*	*2010*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 643***		***Course Title***	***Digital Video Processing***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Digital Signal Processing (TEC 501)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the concept of colour video systems.* ***CO2: Understand*** *motion estimation technique and various block matching algorithm.* ***CO3: Analyse*** *various video coding schemes.* ***CO4: Apply*** *content dependent video coding.* ***CO5: Assess*** *the object-based video coding.* ***CO6: Understand*** *video compression standards.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Video Processing:*** *Principles of color video system, Video display, Composite versus component video, Progressive and interlaced scan, Sampling of video signals, DVI technology.*	*9*
2.	***Unit 2: Motion Estimation Techniques:*** *General methodologies, Pixel based motion estimation, Block matching algorithm, Deformable block matching algorithm, Mesh based motion estimation, Global motion estimation, Region based motion estimation, Multi-resolution motion estimation, and feature based motion estimation.*	*10*
3.	***Unit 3: Basics of Video Coding:*** *Categorization of video coding schemes, Information theory for source coding, Binary encoding, Scalar quantization, Vector quantization, Wave form-based coding, Block-based transform coding, Predictive coding, Temporal prediction and transform coding.*	*9*
4.	***Unit 4: Content dependent Video Coding:***	*9*

	Two-dimensional shape coding, Texture coding for arbitrarily shaped region, Joint shape and texture coding, Region based video coding.	
5.	***Unit 5: Object based Video Coding:*** *Knowledge based video coding, Semantic video coding, Layered coding system Video Compression Standard: Standards, H.261 family of standards.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Y. Wang, J. Ostermann, and Y. Q. Zhang, "**Video Processing and Communications**", Prentice Hall.*	*1st*	*2001*
2.	*Ed. Al Bovik, "**Handbook of Image and Video Processing**", Academic Press.*	*2nd*	*2000*
	Reference Books		
1.	*A. M. Tekalp, "**Digital video Processing**", Prentice Hall.*	*2nd*	*2001*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 659***		***Course Title***	***Advanced Embedded Systems***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Six***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Microcontroller & Embedded Systems (TEC 503)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the working concept of microprocessor and microcontroller.* ***CO2: Understand*** *the architecture and instruction sets of PIC microcontrollers.* ***CO3: Relate*** *the knowledge of system design and peripheral interfacing.* ***CO4: Analyze*** *structure of RTOS in Embedded Systems.* ***CO5: Evaluate*** *PIC and ARM processors as the advanced series.* ***CO6: Integrate*** *the concepts of embedded systems for developing projects.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Embedded systems:*** *Embedded systems vs. General computing systems, History of embedded systems, Classification, Application area. Typical embedded systems, Characteristics and quality attributes of embedded systems.*	*9*
2.	***Unit 2: Intel Family of Microcontrollers PIC Architectures:*** *PIC series of microcontrollers, Instruction set, Addressing modes, Interrupts and timer.*	*9*
3.	***Unit 3: System Design, Peripheral Interfacing:*** *Digital and analog interfacing, Programming framework, Software development.*	*9*
4.	***Unit 4: Real Time Operating Systems (RTOS):***	*9*

	Embedded systems design, Operating system basics, Types of operating system tasks, Process, Threads, Multiprocessing and Multitasking, Task scheduling.	
5.	***Unit 5: 16- and 32-bit Microcontrollers:*** *ARM 32-bit MCU, AMBA bus architecture, Brief introduction to instructions, AVR family, Architecture and overview.*	*9*
	Total	***45***

11.Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	*Edition*	*Year of Publication / Reprint*
	Textbooks		
1.	*Raj Kamal, "**Microcontrollers: Architecture, Programming, Interfacing and System Design**", Pearson Education, India.*	*2nd*	*2005*
2.	*J. Morton, "**The PIC Microcontroller**", Elsevier/Newnes*	*3rd*	*2005*
	Reference Books		
1.	*A. Sloss, D. Symes, C. Wright, "**Arm System Developer's Guide: Designing and optimizing system software**", Morgan Kauffman Publisher*	*1st*	*2004*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 701***		***Course Title***	***Computer Architecture***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSC/ PCC***					
8.	***Pre-requisite***	***Digital Electronics (TEC 302), Microprocessor & Its Applications (TEC 403)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understanding*** *data representation and computer arithmetic.* ***CO2: Designing*** *basic computer and its components.* ***CO3: Understanding*** *program translation into binary code* ***CO4: Implementing*** *parallelism in computing.* ***CO5: Understanding*** *of multiprocessing system and the design of main memory and cache memory.* ***CO6: Design*** *various units and integrating them to form a computing system.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Data representation and computer arithmetic:*** *Data types, complements, fixed point and floating point representations, binary codes, addition and subtraction with signed magnitude data, flow charts, multiplication algorithms, Booth multiplication algorithm, decimal arithmetic unit, reverse polish notation.*	*10*
2.	***Unit 2: Register transfer and micro operations:*** *Register transfer language, register transfer, arithmetic, logic and shift microroperations, arithmetic logic shift unit.* ***Basic computer organization and design:*** *Instruction codes, computer registers, computer instructions, instruction cycle, memory reference, register reference and input output reference instructions, complete computer description, design of basic computer, design of accumulator logic.*	*10*
3.	***Unit 3: Programming the basic computer:***	*9*

	Machine language, assembly language, translation to binary, representation of symbolic program in memory, program loops, input-output programming Central processing unit: *General register organization, stack organization, instruction formats, addressing modes, data transfer and manipulation, RISC and CISC characteristics.*	
4.	***Unit 4: Pipeline and parallel processing:*** *Parallel processing, pipeline, arithmetic pipeline, instruction pipeline, three, four and six segment instruction pipeline, delayed branch* ***Input-Output organization*** *Peripheral devices, input-output interface, modes of transfer, programmed I/O, interrupt-initiated I/O, Priority encoder, Direct Memory Access, DMA controller, Input-Output processor.*	*8*
5.	***Unit 5: Memory organization:*** *Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, locality of reference, hit ratio, associative mapping* ***Multiprocessors:*** *Characteristics of multiprocessors, interconnection structures, time-shared common bus, multiport memory, crossbar switch, multistage switching network, hypercube interconnection.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*M. Morris Mano, "**System Architecture**", Pearson Education.*	*3rd*	*2013*
2.	*Linda Null, Julia Lobur, "**Essentials of Computer Organization and Architecture**", Jones and Bartlett Publishers*	*4th*	*2003*
	Reference Books		
1.	*David A. Patterson, John L. Hennessy, "**Computer Organization and Design – The Hardware / Software Interface**", Morgan Kaufmann Publishers In*	*3rd*	*2005*
2.	*William Stallings, "**Computer Organization & Architecture**", PHI*	*8th*	*2010*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 741***		***Course Title***	***Mobile Ad hoc Networks***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Wireless Communication (TEC 601), Data Communication Networks (TEC 641)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the concept of ad hoc wireless networking, Standards and their design issues and available solution.* ***CO2: Understand*** *MAC layer protocols and design issues of MAC protocols.* ***CO3: Understand and remember*** *proactive, reactive and hybrid routing protocols and routing mechanism.* ***CO4: Understand*** *energy management in ad hoc network.* ***CO5: Understand*** *Security attacks and QoS provisioning in ad hoc network.* ***CO6: Develop and design*** *efficient wireless mobile ad hoc networks.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Ad hoc networking: An introduction. Model of operation, Symmetric links, Fundamental of wireless networks, Bluetooth, IrDA, Comparison of bluetooth and IrDA, Home RF, 802.11, 802.16(Wi-Max), Hotspot, Difference between cellular and ad hoc networks, Technical and research challenges. DoD perspective.*	*8*
2.	***Unit 2: MAC Layer Protocols for Ad hoc Wireless Networks:*** *Need for Medium Access Control(MAC) Protocols, Issues and design goals of MAC protocols, Classification of MAC protocols: Contention based MAC protocols, Contention based MAC protocols with reservation mechanism, Multiple Access Collision Avoidance (MACA), Media Access Protocol for wireless (MACAW), Floor Acquisition Multiple Access Protocols (FAMA), Busy Tone Multiple Access Protocols (BTMA), Multiple Access Collision Avoidance – by Invitation(MACA-BI), Dual Busy Tone Multiple Access Protocols (DBTMA), Multichannel Carrier sense Multiple access (CSMA) MAC Protocol.*	*10*

3.	***Unit 3: Routing Protocols:*** *Design issues of routing protocols, Ideal characteristics of routing, Classification of routing protocols: Proactive, Reactive, Hybrid. Overview of DSDV (Destination sequenced distance vector) Routing protocol, Link state, Distance vector, DSDV properties and its merits demerits, Damping fluctuations. Clustering, Hierarchical routing.* *Overview of DSR (Dynamic Source Routing) protocols: DSR properties, Additional route discovery and maintenance features. Overview of AODV (Ad Hoc On Demand Distance vector) Protocols, Unicasting, Multicasting, Unicast route establishment, Multicasting route establishment, Expanding ring search. Overview of ZRP (Zone Routing Protocol), Reconfigurable wireless networks, Intrazone, Interzone routing protocols. Overview of OLSR (Optimized Link State Routing) Protocol, Multipoint relays (MPRs), Protocol functioning, Core functioning.*	*12*
4.	***Unit 4: Energy management:*** *Energy management system in Ad Hoc networks, Power issues, Smart batteries, and Associatively based routing, Effects of beaconing of battery life, Maximum lifetime routing.*	*7*
5.	***Unit 5: Network Security Attacks and Quality of Service:*** *Security in Ad Hoc wireless networks, Network security requirements, Issues and challenges in security provisioning, Network security attacks. QoS in Ad Hoc wireless networks, Issues and challenges, Classification of QoS solutions. Wireless sensor networks, Issues and challenges, Sensor network architecture, flooding gossiping, Rumor routing, Quality of sensor networks, Evolving standards.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*C. Perkins, "**Ad Hoc Networking**", Addison-Wesley Professional*	*1st*	*2008*
2.	*C. Siva Ram Murthy, and B. S.Manoj, "**Ad Hoc Wireless Networks Architecture and Protocols**", Pearson Education*	*2nd*	*2004*
	Reference Books		
1.	*S. Basagni, And M. Conti, "**Mobile Ad Hoc Networking: Cutting Edge Directions**", John Wiley & Sons*	*2nd*	*2013*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 742***		***Course Title***	***Electronics System Design***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Microcontroller and Embedded System (TEC 503)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** ***CO 1: Understand** the need of System C in designing a system* ***CO 2: Understand** the modeling of systems above the Register transfer Level of abstraction.* ***CO 3: Understand** functional modeling of systems based on requirements* ***CO 4: Understand** the need of communication and synchronization in systems through interfaces and channels.* ***CO 5: Understand** the process of refinement and the need for testing and debugging the system.* ***CO 6: Apply and Analyse** functional modeling based on requirements*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Fundamentals of System C: Modules, Interfaces, Ports and channels, Processes, Events, Sensitivity, Event finder, Module and channel instantiation.*	*8*
2.	***Unit 2: Models of Computation:*** *Introduction, RTL model of computation, Kahn process networks, Static dataflow, Transaction-Level models.* *Classical Hardware modeling with System C: Introduction, Register transfer level modeling, Behavioral-level modeling, Hardware oriented data types.*	*9*
3.	***Unit 3: Functional Modeling:*** *Untimed functional models – dataflow, Timed functional model, Stopping a dataflow simulation.* ***Parameterized Modules and Channels**: Introduction, Forms of parameterization, Parameterized design examples, Protecting intellectual property.*	*10*
4.	***Interface and Channel Design:***	*8*

	Introduction, Interface design, Primitive versus hierarchical channels, Primitive channel examples, Hierarchical channel examples.	
5.	***Communication Refinement:*** *Steps in refinement process, Hardware-hardware communication refinement, Software-software communication refinement.* *Test benches, Tracing and Debugging: Introduction, Test benches, Tracing, Debugging.*	*10*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Grötker, T., Liao, S., Martin, G., Swan, S, "**System Design with SystemC**", Springer.*	*2nd*	*2002*
2.	*J. Bhasker, "**A System C Primer**", Star Galaxy Publishing,*	*2nd*	*2004*
	Reference Books		
1.	*David C. Black and Jack Donovan, "**System C: From The Ground Up**", Kluwer Academic Publishers*	*1st*	*2004*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 743***		***Course Title***	***Design of Analog CMOS Circuit***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Analog Integrated Circuits(TEC 402)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the knowledge of analog IC design in CMOS technologies.* ***CO2: Understand*** *MOS transistors and its working.* ***CO3: Apply*** *differential MOS amplifiers in different electronic circuits.* ***CO4: Analyse*** *current mirror circuits and frequency response of amplifiers.* ***CO5: Assess and evaluate*** *feedback amplifiers and its impact on noise.* ***CO6: Design and develop*** *various analog CMOS circuits.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: MOS Device Physics:*** *MOSFET introduction, MOSFET structure, Working of MOSFET, MOSFET as a switch, MOS I-V characteristics, Threshold voltage, Derivation of I-V characteristics, Small signal models of MOS transistor, MOS transistor frequency response.*	*9*
2.	***Unit 2: Single-stage Amplifier:*** *Common source stage with resistive load, CS stage with diode connected load, CS stage with current source load, CS stage with triode load, CS stage with source generation, Source follower and common gate configuration*	*9*
3.	***Unit 3: Differential Amplifier and Current Mirror:*** *Basic differential pair, Qualitative analysis, Quantitative analysis, Common mode response, Differential pair with MOS loads, basic Current mirror, Cascode current mirror*	*9*
4.	***Unit 4: Frequency Response of Amplifiers:***	*9*

	General consideration, Miller effect, Response of common source stage, Response of source followers, Response of common gate stage, Response of cascode stage, Response of differential pair	
5.	***Unit 5: Noise and Feedback:*** *Types of noise, Thermal noise, Flicker noise, Feedback topologies: Voltage-voltage feedback, Current-voltage feedback, Voltage-current feedback, Current-current feedback, Effect of feedback on noise*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*B. Razavi, "**Design of analog CMOS Integrated Circuits**", McGraw-Hill.*	*1st*	*2002*
2.	*Mohammed Ismail and Terri Faiz, "**Analog VLSI Signal and Information Process**", McGraw-Hill.*	*1st*	*1994*
	Reference Books		
1.	*Paul R. Gray and R. G. Meyer, "**Analysis and Design of Analog Integrated Circuits**", John Wiley and Sons.*	*4th*	*2001*
2.	*R. Jacob Baker, H. W. Li, and D.E. Boyce, "**CMOS: Circuit Design, Layout and Simulation**", Prentice-Hall of India.*	*3rd*	*2010*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 744***		***Course Title***	***Speech Processing***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Digital Signal Processing (TEC 501)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *basic concepts of speech production.* ***CO2: Analyse*** *the predictive coding.* ***CO3: Understand*** *the homomorphic systems.* ***CO4: Analyse*** *speech enhancement techniques.* ***CO5: Understand*** *the analysis of several statistical model for speech recognition.* ***CO6: Develop*** *real-life applications in the area of voice communications.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Fundamentals of the Speech Production mechanism and Digital Speech Processing:*** *Anatomy & physiology of speech organs, The process of speech production, Acoustic phonetics, The acoustic theory of speech production, Lossless tube models, Digital models for speech signals.* *Time domain models for speech processing: Introduction, Window considerations, Short time energy and average magnitude, short time average zero crossing rate, Speech Vs. silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, the short time autocorrelation function, the short time average magnitude difference function, Pitch period estimation using the autocorrelation function.*	*12*
2.	***Unit 2: Linear Predictive Coding (LPC):*** *Basic principles of linear predictive analysis: The autocorrelation method, the covariance method, Solution of LPC equations: Cholesky decomposition solution for covariance method, Durbin's recursive solution for the autocorrelation equations, Pitch detection and using LPC parameters.*	*8*

3.	***Unit 3: Homomorphic Speech Processing:*** *Introduction, Homomorphic systems for convolution: Properties of the complex cepstrum, Computational considerations, the complex cepstrum of speech, Pitch detection, Formant estimation, Mel frequency cepstrum computation, Mel frequency cepstral co-efficients (MFCC) feature extraction.*	*9*
4.	***Unit 4: Speech Enhancement:*** *Nature of interfering sounds, Speech enhancement techniques: Spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter.*	*6*
5.	***Unit 5: Statistical Models for Speech Recognition:*** *Introduction to speaker recognition and speech recognition. Vector quantization model and Gaussian mixture model for speaker and speech recognition. Discrete and continuous hidden Markov modeling for isolated word and continuous speech recognition.*	*10*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Lawrence R. Rabiner, Ronald W. Schafer, "**Introduction to Digital Speech Processing**", Now Publishers Inc.*	*1st*	*2007*
2.	*Thomas F. Quatieri, "**Discrete-Time Speech Signal Processing: Principles and Practice**", Pearson*	*1st*	*2008*
	Reference Books		
1.	*Sadaoki Furui, "**Digital Speech Processing: Synthesis, and Recognition**", CRC Press.*	*2nd*	*2000*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 747***		***Course Title***	***Optical Fiber Communications***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Microwave Engineering (TEC 602)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understanding*** *of different types of optical waveguides and propagation mechanism.* ***CO2: Analysis*** *of attenuation, losses and polarization for different types of optical fiber.* ***CO3: Analysing*** *different optical transmitter sources.* ***CO4: Understanding*** *and* ***analysis*** *of optical detectors and their Performances.* ***CO5: Analysis & applications*** *of optical fiber link by integrating optical transmitter and receiver circuits with application in multiplexing and optical networking.* ***CO6****:* ***Successful*** *completion of this course enables students to apply concepts of optical communication to build optical networks.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Block diagram of optical fiber communication system, Advantages of optical fiber communication, Optical fiber waveguides: Structure of optical wave guide, Step Index fiber, Graded Index Fiber, Single mode, Multimode, light propagation in optical fiber using ray theory, acceptance angle, numerical aperture, skew rays, wave theory for optical propagation, modes in a planar and cylindrical guide, mode volume, cutoff wavelength, mode field diameter, effective refractive index and group and mode delay factor for single mode fiber.*	*10*
2.	***Unit 2: Attenuation in optical fibers:*** *Intrinsic and extrinsic absorption, linear and nonlinear scattering losses, fiber bend losses. Dispersion and pulse broadening, Graded Index fibers,*	*12*

	intramodal and intermodal dispersion for step and graded index fibers, over all fiber dispersion for multimode and monomode fiber, modal birefringence and polarization maintaining fibers.	
3.	***Unit 3: Optical Sources:*** *LED and LASER structures, Characteristics and drive circuits, Nd:YAG LASER, He-Ne Laser, CO_2 Laser, Distributed Feedback Laser. Concept of Optical Amplification*	*6*
4.	***Unit 4: Optical detectors:*** *Requirement for photo detections p-n photodiode, characteristics of photo detections, p-i-n and avalanche photodiodes, phototransistors & photoconductors. Direct detection receivers. Performance considerations: Noise sources in optical fiber communication, noise in p-n, p-i-n and APD receiver, Optical Time Domain Reflectometry (OTDR), Optical power meters.*	*8*
5.	***Unit 5: Receiver structure Optical fiber communication systems:*** *Optical receiver block diagram, simple circuits for pre-amplifier, automatic gain control and equalization, optical system design, Multiplexing, Coherent and non-coherent detection, WDM, OTDM.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*John M S Senior, "**Optical Fiber Communication"**, PHI*	*3rd*	*2009*
2.	*G E Keiser, "**Optical Fiber Communication"**, McGraw-Hill*	*5th*	*2013*
	Reference Books		
1.	*Joseph C Palais, "**Fiber Optic Communications**", Person.*	*5th*	*2005*
2.	*Govind P Agrawal, "**Fiber-Optic Communication Systems**", Wiley*	*3rd*	*2015*
3.	*Wilson & Hawkes, "**Optoelectronics, an Introduction**", PHI,*	*3rd*	*1998*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 748***		***Course Title***	***ASIC and FPGA Design***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***VLSI Technology and Design (TEC 603)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Describe*** *the working principle of ASIC, CMOS logic and FPGA.* ***CO2: Understand*** *the basic structure of ASIC and FPGA families.* ***CO3: Apply*** *the concepts of ASIC and FPGA interconnection in designing various electronic circuits.* ***CO4: Analyse*** *the process of implementing design on FPGA.* ***CO5: Evaluate*** *ASIC and FPGA design using EDA tool to optimize the device performance.* ***CO6: Design*** *SOC based integrated circuits for various applications*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction****:* *Introduction to ASICs, CMOS logic and ASIC library design, Types of ASICs, Design flow, CMOS transistors, CMOS design rules, Combinational logic cell, Sequential logic cell, Library architecture. Review of VHDL/Verilog: Entities and architectures.*	*10*
2.	***Unit 2: ASIC and FPGA Families:*** *Programmable ASIC logic cells and programmable ASIC I/O cells anti fuse, Static RAM, EPROM and EEPROM technology, PREP benchmarks, DC & AC inputs and outputs, Clock & power inputs, Xilinx I/O blocks.*	*9*
3.	***Unit 3: ASIC and FPGA Interconnect:*** *ASIC design software and low-level design entry, Xilinx LCA, Xilinx EPLD, Altera FLEX, Design systems, Logic synthesis, Half gate ASIC, Schematic entry, Low level design language, PLA tools, EDIF, CFI design representation.*	*10*
4.	***Unit 4: FPGA Implementation:***	*8*

	FPGA partitioning, partitioning methods, Floor planning, Placement, Physical design flow, Global routing, Detailed routing, Special routing, Circuit extraction, DRC.	
5.	***Unit 5: FPGA Applications:*** *FPGA and advance Silicon on Chip (SOC) class FPGA, SOC design flow, Platform-based and IP based SOC designs.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*M.J.S .Smith, "**Application - Specific Integrated Circuits**", Addison –Wesley Longman Inc.*	*1st*	*2002*
2.	*Skahill, Kevin, "**VHDL for Programmable Logic**", Pearson Education".*	*1st*	*2006*
	Reference Books		
1.	*John F. Wakherly, "**Digital Design: Principles and Practices**", Prentice Hall.*	*4th*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 749***		***Course Title***	***Radar and Navigation Aids***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Antenna and Wave Propagation (TEC 504), Microwave Engineering (TEC 602)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *the concept of Radar and its application.* ***CO2: Analyse*** *MTI and Pulsed Doppler radar.* ***CO3: Investigate*** *the detection of signal and noise in it.* ***CO4: Understand*** *the concepts of navigation.* ***CO5: Formulate*** *Doppler navigation system and its accuracy.* ***CO6: Design*** *various radar and navigation-based systems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to Radar Basics:*** *The simple form of the radar Equation, Radar block diagram, Radar frequencies, Applications of radar, Detection of signals in noise, Receiver noise and the signal-to-noise ratio, Probability density functions, Probabilities of detection and false alarm, Integration of radar pulses, Radar cross section of targets, Radar cross section fluctuations, Transmitter power, Pulse repetition frequency, Antenna parameters, System losses.*	*10*
2.	***Unit 2: MTI and Pulse Doppler Radar:*** *Introduction to Doppler and MTI radar, Delay line cancelers, Staggered pulse repetition frequencies, Moving target detector, Limitations to MTI performance, Pulse Doppler radar, Doppler filters, Tracking with radar, Monopulse tracking, Conical scan, Sequential lobing, Tracking in range.*	*9*
3.	***Unit 3: Radar Transmission and Detection of Signals in Noise:*** *Radar transmitters, Linear beam power tubes, Solid state RF power sources, Magnetron, Crossed field amplifiers. The radar receiver, Receiver noise figure, Super heterodyne receiver, Duplexers and receiver protectors, Matched filter receiver, Detection criteria, Detectors, Automatic detector, Constant*	*9*

	false alarm rate receivers, Propagation of waves, atmospheric refraction, Standard propagation, Nonstandard propagation, Radar clutter, land and sea clutter, Detection of target in precipitation, The Radar antenna, Reflector antennas, Electronically steered phased array antennas, Phase shifters, Frequency-scan Arrays.	
4.	***Unit 4: Introduction to Navigation:*** *Radio direction finding, The Loop antenna, Loop Input/output circuits, an aural null direction finder, the goniometer, Errors in direction finding, Adcock direction finder, Automatic direction finders, The Commutated aerial direction finder, Range and accuracy of direction finders, The LF/MF four course radio range, VHF Omni Directional Range Finder (VOR), VOR receive ring equipment, Range and accuracy of VOR.*	*8*
5.	***Unit 5: Distance Measuring Equipment (DME) and Tactical Air Navigation (TACAN):*** *Operation of DME and TACAN, Instrument landing system, Ground controlled approach system, Microwave Landing System(MLS), Doppler navigation, Beam configurations, Track stabilization, Doppler spectrum, Components of the Doppler navigation system, Accuracy of Doppler navigation systems, Inertial navigation, Principles of operation, Navigation over the earth, Components of an inertial navigation system, Earth coordinate mechanization, Strapped-down systems, Accuracy of inertial navigation systems, Global Positioning System (GPS).*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*M. I. Skolnik, "**Introduction to Radar Systems**", Tata McGraw-Hill*	*3rd*	*2017*
2.	*N. S. Nagaraja, "**Elements of Electronics Navigation**", Tata McGraw-Hill*	*2nd*	*2017*
	Reference Books		
1.	*P. Z. Peebles, **"Radar Principles**", Willey*	*1st*	*2007*
2.	*J.C Toomay, "**Principles of Radar**", PHI*	*2nd*	*2004*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 750***		***Course Title***	***Organic Electronics***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Electronics Devices and Circuits (TEC 301).***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Remember*** *the basics and limitations of conventional silicon-based semiconductor devices.* ***CO2: Understand*** *the basic concepts and classification of organic materials.* ***CO3: Apply*** *the basic concepts of charge transport in organic materials for different organic electronic devices.* ***CO4: Analyze*** *the different properties of OLED.* ***CO5: Evaluate*** *the performance of organic solar cells.* ***CO6: Design and develop*** *innovative organic electronic devices.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Organic Materials:*** *Introduction to Organic materials, Review of inorganic semiconductors and their properties, Comparison between organic and inorganic semiconductors, Concept of charge transport in organic semiconductors, Conjugated small molecules and polymers, Electronic structure: hybridization of atomic orbital, molecular orbital, Molecular structure-process-property relationships, Characterization: UV-vis, Cyclic Voltammetry, XRD, Quantum Efficiency, Impedance Spectroscopy, charge extraction in linear increase voltage (CELIV)*	*10*
2.	***Unit 2: Organic Thin Film Transistors(OTFTs):*** *Introduction; Operating principle; Output and transfer characteristics; Classification of various organic thin film transistors (OTFT) structures; Performance parameters, Single Gate (SG) and Dual Gate (DG) TFT performance comparison; Merits, Demerits, Limitations, future scope and applications.*	*10*
3.	***Unit 3: Organic Sensors:***	*10*

	Introduction; Working principle and organic sensing materials for pressure sensors (Piezoresistive, Piezoelectric, and Capacitive sensor), Temperature sensors, Humidity sensors; comparison between organic and conventional sensors including merits, demerits and limitations; Applications of organic sensors	
4.	***Unit 4: Light-emitting diodes and Solar cell;*** ***Introduction;*** *Organic materials for OLEDs; Classification of OLEDs, operating principle; Output and transfer characteristics; Analysis of OLED performance: Optical, Electrical and thermal properties, Merits and demerits; OLED Applications.* ***Solar cell Introduction;*** *Operating principle; Characteristics; Materials for organic solar cells; Classification of organic solar cell- Single layer, Bi-layer and bulk hetero junction organic solar cell; Merits and demerits, Applications and future scope.*	*9*
5.	***Unit 5: Flexible Electronics and High-Speed Printing:*** *Organic devices on flexible substrate, Technologies of roll-to-roll printing, Stretchable electronics, Sintering of metal nanoparticles as contacts*	*6*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Hagen Klauk, "**Organic Electronics: Materials, Manufacturing and Applications**", Wiley-VCH VerlagGmbh & Co. KGaA, Germany.*	*1st*	*2006*
2.	*Klaus Mullen, UllrichScherf, "**Organic Light Emitting Devices: Synthesis, Properties and Applications**", Wiley-VCH VerlagGmbh& Co. KGaA, Germany.*	*1st*	*2005*
3.	*Johannes Karl Fink, "**Polymeric Sensors and Actuators**", John Wiley & Sons*	*1st*	*2012*
	Reference Books		
1.	*Hagen Klauk, "**Organic Electronics II: More Materials and Applications**", Wiley-VCH VerlagGmbh& Co. KGaA, Weinheim, Germany.*	*1st*	*2012*
2.	*Flora Li, Arokia Nathan, Yiliang Wu, Beng S. Ong, "**Organic Thin Film Transistor Integration: A Hybrid Approach**", Wiley-VCH, Germany.*	*1st*	*2011*
3.	*Wolfgang Brutting, "**Physics of Organic Semiconductors**", Wiley-VCH VerlagGmbh& Co. KGaA, Germany.*	*2nd*	*2005*
4.	*Daniel A. Bernards, Róisín M. Owens, George G. Malliaras, "**Organic Semiconductors in Sensor Applications**", Springer Science & Business Media.*	*1st*	*2008*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 791***		***Course Title***	***Internet of Things and Its Applications***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Seven***					
7.	***Category of Course***	***DSC/PCC***					
8.	***Pre-requisite***	***Advanced Embedded Systems (TEC 659)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the knowledge of wireless sensor network and Internet of things.* ***CO2: Understand*** *IoT Market perspective.* ***CO3: Apply*** *the State of the Art – IoT architecture.* ***CO4: Analyse*** *the applications of IoT.* ***CO5: Assess and evaluate*** *IoT applications for privacy, security, and governance.* ***CO6: Design and develop*** *various IoT based applications.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction to IoT:*** *Introduction to sensor networks, Unique constraints and challenges, Advantage of sensor networks, Defining IoT, Characteristics of IoT, Physical design of IoT: Things in IoT, Physical design, Logical design of IoT, Functional blocks of IoT, IoT communication models, Applications of sensor networks in IoT.*	*9*
2.	***Unit 2: M2M to IoT – A Basic Perspective:*** *Introduction, some definitions, M2M value chains, IoT value chains, an emerging industrial structure for IoT, The international driven global value chain and global information monopolies.* ***M2M to IoT-An Architectural Overview:*** *Building architecture, Main design principles and needed capabilities, An IoT architecture outline, Standard considerations.*	*9*
3.	***Unit 3: IoT Architecture -State of the Art:***	*9*

	Introduction, State of the art, Architecture reference model- Introduction, Reference model and architecture, IoT reference model, *IoT Reference Architecture:* *Introduction, Functional view, Information view, Deployment and operational view, Other relevant architectural views.*	
4.	***Unit 4: Domain Specific IoT Applications:*** *Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and lifestyle.*	*9*
5.	***Unit 5: Internet of Things Privacy, Security and Governance:*** *Introduction, Overview of governance, Privacy and security issues, Contribution from FP7 projects, Security, Privacy and trust in IoT-data-platforms for smart cities, First step towards a secure platform, Smartie approach. Data aggregation for the IoT in smart cities, Security.*	*9*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Vijay Madisetti and Arshdeep Bahga, "**Internet of Things-A Hands-on-Approach**", Orient Blackswan Private Limited.*	*1st*	*2015*
2.	*Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "**From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence**", Academic Press.*	*1st*	*2014*
	*Francis daCosta, "**Rethinking the Internet of Things: A Scalable Approach to Connecting Everything**", Apress Media.*	*1st*	*2013*
	Reference Books		
1.	*Cuno Pfister, "**Getting Started with the Internet of Things**", O'Reilly Media,*	*1st*	*2011*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 841***		***Course Title***	***Satellite Communications***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Microwave Engineering (TEC 602)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to**:*** ***CO1: Understand*** *basic concepts of orbital mechanism and launch vehicle.* ***CO2: Apply*** *the technologies for satellite & earth station architecture, and applications.* ***CO3: Analyse*** *the satellite link for the optimum link performance.* ***CO4: Evaluate*** *the modulation and coding schemes for a given satellite communication link.* ***CO5: Understand*** *various satellite systems - worldwide and Indian scenario**.*** ***CO6: Design*** *prototype satellite communication link for given specifications.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Overview of Satellite Systems, Orbits and Launching Methods:*** *General features, Frequency allocation, Properties of satellite communication systems, LEO, MEO and GEO Orbits, Kepler's laws, Orbital dynamics, Orbital elements, Sub-satellite point, Orbital perturbations, Orbital effects on communication system performance. Launching and positioning of satellite. Antenna look angle determination, Sub-satellite point, Limits of visibility.*	*9*
2.	***Unit 2: Space Segment (Satellite Subsystems) and Earth Station:*** *Attitude and orbit control system; Telemetry, Tracking, Command and monitoring (TTC & M); Communication subsystems, Antenna subsystem, Power system, Equipment reliability and space qualification. Different types of earth stations.*	*9*
3.	***Unit 3: Satellite Link Design:***	*9*

	Basic transmission theory, General link design equation, System noise temperature, Uplink/Down Link design, C/N ratio, Saturation flux density, Input/Output back off, Effect of rain: Attenuation and depolarization.	
4.	***Unit 4: Satellite Multiple Access Techniques:*** *Multiplexing and multiple access, Preassigned, Demand assigned multiple access, FDMA- Bandwidth limited and power limited TWT amplifier operation; TDMA- TDMA frame structure, Frame efficiency, Comparison of uplink power requirements for FDMA and TDMA. CDMA- Direct-sequence spread spectrum, M-sequence codes, Spectrum spreading and dispreading*	*10*
5.	***Unit 5: Introduction of Various Satellite Systems:*** *VSAT Systems, DBS, DTH; LEO and non-Geosystems- RADARSAT, IRIDIUM, INMARSAT, ORBCOMM, Global Positioning System (GPS), IRNSS (NavIC).*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Pratt and Bostian, **"Satellite Communications"**, John Wiley & Sons.*	*3rd*	*2019*
2.	*Dennis Roddy, **"Satellite Communications"**, McGraw-Hill*	*4th*	*2017*
	Reference Books		
1.	*Louis J. Ippolito Jr. "**Satellite Communications Systems Engineering**", Willey.*	*1st*	*2008*
2.	*Bruce R. Elbert, "**Introduction to Satellite Communication**", Artech House.*	*3rd*	*2008*
3.	*Tri T. Ha, **"Digital Satellite Communications"**, McGraw Hill*	*2nd*	*2009*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 842***		***Course Title***	***Testing of VLSI circuits***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***VLSI Technology and Design (TEC 603)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Recall*** *the knowledge of fault modeling and fault simulation.* ***CO2: Understand*** *ATPG algorithm for combinational and sequential circuits.* ***CO3: Apply*** *the knowledge in understanding high-level testability Measures, SCOAP controllability and observability.* ***CO4: Analyse*** *different memory testing algorithms.* ***CO5: Assess and evaluate*** *scan architecture.* ***CO6: Design*** *testing algorithms for VLSI components.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Role of testing, Digital and analog VLSI testing, VLSI technology trends affecting testing.* ***VLSI Testing Process and Test Equipment:*** *How to Test Chips, Types of Testing, Automatic Test Equipment, Electrical Parametric Testing* ***Test Economics and Product Quality:*** *Defining Costs, Production, The Rule of Ten, Yield, Defect Level as a Quality Measure*	9
2.	***Unit 2: Fault Modeling:*** *Defects, Errors, and Faults, Functional versus structural testing, Levels of fault models, A glossary of fault models, Single stuck-at fault, Fault Equivalence, Equivalence of Single Stuck-at Faults, Fault Collapsing* ***Logic and Fault Simulation:*** *Simulation for design verification, Simulation for test evaluation, Modeling circuits for simulation, Algorithms for True-Value Simulation, Compiled-Code Simulation, Event-Driven Simulation.*	9

3.	***Unit 3: Testability Measures:*** *SCOAP controllability and observability, Combinational SCOAP Measures, Sequential SCOAP Measures, High-level testability measures.* ***Combinational Circuit Test Generation:*** *Algorithms and representations, Structural vs. Functional Test, Definition of Automatic Test-Pattern Generator, Redundancy Identification (RID), Testing as a global problem, Definitions, Significant combinational ATPG algorithms and sequential circuit test generation, D-Calculus and D-Algorithm (Roth), Test generation systems, Test compaction.*	10
4.	***Unit 4: Memory Test:*** *Memory density and defect trends, Faults, Memory test levels, March test notation, Fault modelling, Memory testing. Analog and mixed signal test, Delay test and IDDQ test.*	8
5.	***Unit 5: Digital DFT and Scan Design:*** *Ad-Hoc DFT Methods, Scan Design, Tests for Scan Circuits* ***System Test and Core-Based Design:*** *System Test Problem Defined, Functional Test, Diagnostic Test, Core-Based Design and Test-Wrapper.*	9
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Viswani D. Agarval Michael L. Bushnell, "**Essentials of electronic testing for digital memory & mixed signal VLSI circuit**", Kluwer Academic Publications*	*1st*	*1999*
2.	*Alfred L. Crouch, "**Design for test for digital IC's and embedded core systems**", PHI*	*1st*	*1999*
	Reference Books		
1.	*Parag. K. Lala, "**Digital circuit testing and testability**", Academic Press*	*1st*	*1997*
2.	*Ashok K. Sharma, "**Semiconductor memories technology, testing and reliability**", Prentice-Hall of India Private Limited*	*1st*	*1997*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 843***		***Course Title***	***Digital System using VHDL***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Digital Electronics (TEC-302)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understand*** *VHDL including code structure.* ***CO2: Describe*** *data type operators and attributes for arithmetic's operations, digital design with SM chart, data type, operation and component.* ***CO3: Analyse:*** *Concurrent code, sequential code, packages and components.* ***CO4: Design*** *network for mathematics operations, digital design with SM chart* ***CO5: Analyse*** *floating-point arithmetic and design examples.* ***CO6: Apply*** *concepts of Digital system design using VHDL.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1:*** ***Introduction to VHDL:*** *Design Flow, EDA Tools, and Translation of VHDL code into a circuit.* ***Code Structure:*** *Fundamental VHDL Units, library Declarations, entity, Architecture, VHDL Design Methodology.*	*10*
2.	***Unit 2: Data Types:*** *Pre-Defined Data Types, User-Defined Data Types, Subtypes, Arrays, Port Array, Records, Signed and Unsigned Data Types, Data Conversion.* ***Operators and Attributes:*** *Operators, Attributes, User-Defined Attributes, Operator Overloading, generic*	*9*
3.	***Unit 3: Concurrent Code:*** *Concurrent versus Sequential, Using Operators, when, generate, block statements.* ***Sequential Code:*** *Process, signals and variables, if, wait, case, loop, case versus if, case versus when, using sequential code to design combinational circuits, signals and variables: constant, signal, variable, number of registers.*	*10*

	Packages and Components: *Introduction, package, component, port map, generic map. functions and procedures: function, function location, procedure, procedure location, function versus procedure, assert.*	
4.	***Unit 4: Design of Networks for Arithmetic Operations:*** *Design of serial adder with accumulator, state graph for control networks design of Binary Multiplier, multiplication of signed binary numbers, design of binary divider.* ***Digital Design with SM Chart:*** *State machine charts, derivation of SM charts, realizations of SM charts, implementation of dice game.*	*8*
5.	***Unit 5: Floating Point Arithmetic:*** *Representation of floating-point numbers, floating-point multiplication, and other floating-point operations.* ***Design Examples:*** *UART design, design of microcontroller.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Volnei A. Pedroni, "**Circuit Design and Simulation with VHDL", MIT Press.*	*2nd*	*2010.*
2.	*Charles H Roth Jr, "**Digital System Design using VHDL", Cengage Learning.*	*Indian Edition*	*2006*
3.	*Jayaram Bhasker, "**A VHDL Primer", Prentice Hall.*	*3rd*	*2007.*
	Reference Books		
1.	*Douglas L. Perry, "**VHDL: Programming by Example", Tata Mcgraw-hill.*	*4th*	*2002*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 844***		***Course Title***	***Cognitive Radio***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/PEC***					
8.	***Pre-requisite***	***Wireless Communication (TEC-601)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Gain*** *knowledge on multi-rate systems.* ***CO2: Develop*** *the ability to analyze, design, and implement any application using FPGA.* ***CO3: Apply*** *signal processing concepts can be used for efficient FPGA based system design.* ***CO4: Understand*** *the rapid advances in Cognitive radio technologies.* ***CO5: Explore*** *DDFS, CORDIC and its application.* ***CO6: Apply*** *the concepts of multi rate signal processing and cognitive radio for next generation of Communication.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Filter banks:*** *Uniform filter bank. Direct and DFT approaches. Introduction to ADSL Modem. Discrete multi-tone modulation and its realization using DFT.QMF. STFT. Computation of DWT using filter banks.*	*9*
2.	***Unit 2: Direct digital frequency synthesis (DDFS):*** *ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC. CORDIC architectures.*	*9*
3.	***Unit 3: Introduction to software radio:*** *Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes.*	*9*
4.	***Unit 4: Cognitive Radio and SDR:***	*8*

	Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks, Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design	
5.	***Unit 5: OFDM System Model:*** *A Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation. Spectrum sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.*	*10*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*J. H. Reed, "**Software Radio**", Pearson.*	*1st*	*2002*
2.	*Charles H Roth Jr, "**Digital System Design using VHDL**", Cengage Learning.*	*Indian Edition*	*2006*
3.	*Jayaram Bhasker, "**A VHDL Primer**", Prentice Hall.*	*3rd*	*2007.*
	Reference Books		
1.	*Douglas L. Perry, "**VHDL: Programming by Example**", Tata Mcgraw-hill.*	*4th*	*2002*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 851***		***Course Title***	***Telecommunication Switching***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Communication Systems II (TEC- 502)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: Understand*** *modern telecommunication network and its heterogeneous switching.* ***CO2: Apply*** *the concepts of traffic engineering to telecommunication network.* ***CO3: Analyse*** *Single stage and Multistage switch networks & single and dual processor systems.* ***CO4: Estimate*** *the performance of telecommunication networks.* ***CO5: Design*** *circuit switched networks with packet switched networks.* ***CO6: Apply*** *the concepts of network and traffic engineering in telecommunication and switching networks.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction:*** *Evolution of public switched telecommunication, Simple telephone communication, Basic of switching system, Concept of Strowger and crossbar switching.*	*8*
2.	***Unit 2: Electronic Space Division Switching:*** *Stored program control, Centralized and distributed SPC, Software architecture, Application software, Enhanced software, Two and three-stage networks.* ***Time Division Switching:*** *Sampling, Quantization, Encoding, Basic time division space switching, Basic time division time switching, Time multiplexed space and time switching, Combination switching.*	*9*
3.	***Unit 3: Traffic Engineering:*** *Network traffic load and parameters, Grade of service, Modeling switching, Incoming traffic, Common channel signaling, SS7 signaling protocols.*	*10*

	Telephone Networks: *Subscriber loop system, Switching hierarchy and routing, Transmission plan, Transmission system, Signaling techniques.*	
4.	***Unit 4: Integrated Digital Network:*** *Digital multiplexing techniques- (Time division multiplexing, Frequency division multiplexing), TDMA, FDMA, and CDMA, Concept of ISDN, ISDN standards, Cellular mobile communication.*	*10*
5.	***Unit 5: Data Networks****:* *Data transmission in PSTN, Switching techniques, Data communication architecture, Link to link layers, End to end layers, OSI Architecture, satellite-based data networks, LAN, MAN standards, TCP/IP, Internet, Principle of ATM networks.*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Thiagarajan Viswanathan, "**Telecommunication switching systems and Networks**", Prentice Hall of India LTD*	*2nd*	*2015*
2.	*Forouzen, "**Data Communications and Networking**", TMH Publishers*	*4th*	*2007*
	Reference Books		
1.	*J. E. Flood, "**Telecommunications Switching, Traffic and Networks**", Pearson Education*	*1st*	*2006*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 852***		***Course Title***	***Optimization Methods in Machine Learning***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Linear Algebra (TEC 344)***					

9.	***Course Outcomes***	***After completion of the course the students will be able to:*** ***CO1: To learn*** *the basic concepts of convex optimization.* ***CO2: To study*** *gradient based optimization techniques.* ***CO3: To understand*** *the problem-solving using operator splitting methods.* ***CO4: To learn*** *stochastic and non-convex optimization Techniques.* ***CO5: To execute*** *applications of optimization techniques in different domains.* ***CO6: Develop*** *the advanced techniques and methods in optimization that are tailored to large-scale statistics and machine learning problems.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Basics of convex optimization:*** *Convex sets, convexity-preserving operations, examples of convex programs, linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality.*	*10*
2.	***Unit 2: Gradient-based methods:*** *Gradient descent, subgradient, mirror descent, Frank–Wolfe method, Nesterov's accelerated gradient method, ODE interpretations, dual methods, Nesterov's smoothing, proximal gradient methods, Moreau–Yosida regularization.*	*10*
3.	***Unit 3: Operator splitting methods:*** *Augmented Lagrangian methods, alternating direction method of multipliers (ADMM), monotone operators, Douglas–Rachford splitting, primal and dual decomposition.*	*9*
4.	***Unit 4: Stochastic and nonconvex optimization:***	*9*

	Dualaveraging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning.	
5.	***Unit 5: Applications of optimization methods:*** *Applications of optimization methods in Image/Video/Multimedia Processing.*	*7*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Stephen Boyd and Lieven Vandenberghe's, "**Convex Optimization**", Cambridge University Press.*	*1st*	*2004*
2.	*Nesterov's, "**Introductory Lectures on Convex Optimization: A Basic Course**", Springer New York*	*1st*	*2004*
3.	*Sra Suvrit, Nowozin Sebastian, Wright Stephen J., "**Optimization for Machine Learning**", PHI Learning Private Limited*	*1st*	*2013*
	Reference Books		
1.	*Charu C. Aggarwal, "**Linear Algebra and Optimization for Machine Learning**", Springer*	*1st*	*2020*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 853***		***Course Title***	***Wireless Sensor Networks***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/ PCC***					
8.	***Pre-requisite***	***Wireless Communication (TEC 601)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Understanding*** *the basic concepts and applications of wireless sensor networks (WSN).* ***CO2: Learning*** *technologies for WSN.* ***CO3: Analyzing*** *different routing protocols of WSN.* ***CO4: Analyzing*** *dissemination protocols of WSN.* ***CO5: Understanding*** *and analyzing design principles of wireless sensor network.* ***CO6: Develop*** *various real time applications using WSN.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Introduction of Wireless Sensor Networks (WSNs):*** *Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks*	*8*
2.	***Unit 2: WSNs enabling technologies, challenges:*** *Classification of WSNs Mobile Ad-hoc Networks (MANETs) and wireless sensor networks, Enabling technologies for wireless sensor networks. Issues and challenges in wireless sensor networks.*	*9*
3.	***Unit 3: MAC and Data Link Layer:*** *MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee.*	*10*
4.	***Unit 4: Routing and Transport Controls Protocol:*** *Routing protocols, Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.*	*9*
5.	***Unit 5: WSNs Design Principles:***	*9*

	Design Principles for WSNs, Gateway Concepts & Need for gateway, WSN to Internet Communication, and Internet to WSN Communication. Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.	
	Total	***45***

11.Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Feng Zhao & Leonidas J. Guibas, "**Wireless Sensor Networks-An Information Processing Approach**", Elsevier*	*1st*	*2014*
2.	*Mohammad Ilyas, ImadMahgoub, "**Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems**", CRC Press.*	*1st*	*2004*
3.	*Holger Karl and Andreas Wiilig, "**Protocols and Architectures for Wireless Sensor Networks**", John Wiley and Sons Limited*	*1st*	*2017*
	Reference Books		
1.	*KazemSohraby, Daniel Minoli, &TaiebZnati, "**Wireless Sensor Networks-Technology, Protocols, and Applications**", John Wiley and Sons Limited*	*1st*	*2016*
2.	*Jun Zheng and Abbas Jamalipour, "**Wireless Sensor Networks-A Networking Perspective**", John Wiley and Sons Limited*	*1st*	*2014*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***TEC 854***		***Course Title***	***Adaptive Signal Processing***		
2.	***Contact Hours***	***L***	***3***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***03***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***03***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***DSE/ PEC***					
8.	***Pre-requisite***	***Digital Signal Processing (TEC 501)***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* ***CO1: Create*** *and visualize the domain of adaptive signal processing.* ***CO2: Identify*** *a random process and formulate to extract desired information.* ***CO3: Develop*** *algorithms meeting application specific performance criteria.* ***CO4: Implement*** *the adaptive algorithms in software/Hardware.* ***CO5: Analyse*** *convergence and stability issues associated with adaptive filter design and come up with optimum solutions for real life applications.* ***CO6: Design and implement*** *filtering solutions for applications, such as channel equalisation, interference cancelling and prediction considering present day challenges.*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***Unit 1: Adaptive Systems:*** *Definitions and characteristics - Applications – Properties-Examples - Adaptive linear combiner input signal and weight vectors - Performance function-Gradient and minimum mean square error - Introduction to filtering-Smoothing and prediction - Linear optimum filtering-Orthogonality - Wiener – Hopf equation-Performance surface*	*10*
2.	***Unit 2: Searching Performance Surface-Stability and Rate of Convergence:*** *Learning curve-Gradient search - Newton's method - Method of steepest descent - Comparison - Gradient estimation - Performance penalty - Variance - Excess MSE and time constants – Mis-adjustments*	*10*
3.	***Unit 3: LMS algorithm convergence of weight vector:***	*9*

	LMS/Newton algorithm - Properties - Sequential regression algorithm - Adaptive Recursive filters - Random-search algorithms - Lattice structure - Adaptive filters with orthogonal signals	
4.	***Unit 4: Applications-adaptive modeling and system identification:*** *Multipath communication channel, Geophysical exploration, FIR digital filter synthesis*	*8*
5.	***Unit 5: Inverse adaptive modeling:*** *Equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis*	*8*
	Total	***45***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*Simon Haykins, "**Adaptive Filter Theory**", Pearson Education.*	*5th*	*2013*
2.	*D. G. Manolakis, V.K. Ingle, S.M. Kogon, "**Adaptive Signal Processing**", McGraw-Hill*	*1st*	*2000*
	Reference Books		
1.	*Todd K. Moon, Wynn C. Stirling, "**Mathematical Methods and Algorithms for Signal Processing**", Prentice Hall*	*1st*	*1999*
2.	*John. R. Triechler, C. Richard Johnson (Jr), Michael. G. Larimore, "**Theory and Design of Adaptive Filters**", Prentice Hall India Private Limited*	*1st*	*2004*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VIII

Sr. No.	***Department of Electronics and Communication Engineering***						
1.	***Subject Code***	***DM001***		***Course Title***	***Disaster Management***		
2.	***Contact Hours***	***L***	***2***	***T***	***0***	***P***	***0***
3.	***Examination Duration***	***Theory***	***02***		***Practical***	***0***	
4.	***Relative Weight***	***CIE***	***25***	***MSE***	***25***	***ESE***	***50***
6.	***Credit***	***02***					
6.	***Semester***	***Eight***					
7.	***Category of Course***	***SEC/HSMC***					
8.	***Pre-requisite***	***Basic Knowledge of Science and Management***					

9.	***Course Outcomes***	*After completion of the course the students will be able to:* *CO1:* ***Understand*** *the foundations of hazards, disasters, and associated natural/social phenomena in India* *CO2:* ***Study*** *the various natural disasters.* *CO3:* ***Study*** *the various manmade disasters.* *CO4:* ***Understand*** *the disaster management principles.* *CO5:* ***Study*** *the modern techniques used in disaster mitigation and management.* *CO6:* ***Formulate*** *Technological innovations in Disaster Risk Reduction*

10. Details of the Course

Sl. No.	***Contents***	***Contact Hours***
1.	***UNIT 1*** ***Introduction, Definitions, and Classification:*** *Concepts and definitions - Disaster, Hazard, Vulnerability, Resilience, Risks* *Natural disasters: Cloud bursts, earthquakes, Tsunami, snow, avalanches, landslides, forest fires, diversion of river routes (ex. Kosi river), Floods, Droughts Cyclones, volcanic hazards/ disasters (Mud volcanoes): causes and distribution* *Hazardous effects and environmental impacts of natural disasters: mitigation measures, natural disaster-prone areas in India, major natural disasters in India with special reference to Uttarakhand.* *Man-induced disasters: water logging, subsidence, groundwater depletion, soil erosion, the release of toxic gases and hazardous chemicals into the environment, and nuclear explosions.*	*9*
2.	***UNIT 2*** ***Inter-relationship between Disasters and Development:*** *Factors affecting vulnerabilities: differential impacts, impacts of development projects such as dams, embankments, changes in land use, etc. climate change adaption, the relevance of indigenous knowledge, appropriate technology and local resources, sustainable development, and its role in disaster mitigation.*	*8*

	Roles and responsibilities of the community: Panchayat Raj institutions/urban local bodies, state, center, and other stakeholders in disaster mitigation.	
3.	***UNIT 3*** ***Disaster Management (Pre-disaster stage, Emergency stage, and Post Disaster Stage)*** ***1. Pre-disaster stage (preparedness):*** *Preparing hazard zonation maps, predictably/forecasting and warning, preparing disaster preparedness plans, land use zoning, preparedness through information, education and communication (IEC), disaster resistant house construction, population reduction in vulnerable areas, awareness* ***2. Emergency Stage:*** *Rescue training for search & operation at national & regional level, immediate relief, assessment surveys* ***3. Post Disaster stage:*** *Rehabilitation and reconstruction of disaster-affected areas; urban disaster mitigation: Political and administrative aspects, social aspects, economic aspects, environmental aspects.*	*9*
4.	***UNIT 4*** ***Disaster Management Laws and Policies in India:*** *Environmental legislations related to disaster management in India: Disaster Management Act,2005* ***Environmental policies & programs in India- Institutions & national centres for natural disaster mitigation:*** *National Disaster Management Authority (NDMA): structure and functional responsibilities, National Disaster Response Force (NDRF): Rule and responsibilities, National Institute of Disaster Management (NlDM): Rule and responsibilities*	*8*
	Total	***34***

11. Suggested Books

SL. No.	***Name of Authors/Books/Publishers***	***Edition***	***Year of Publication / Reprint***
	Textbooks		
1.	*M M. Sulphey, "**Disaster Management**", PHI*	*1st*	*2017*
	Reference Books		
1.	*S C Sharma, "**Disaster management**", Khanna Book Publishing*	*2nd*	*2022*

12.	***Mode of Evaluation***	*Test / Quiz / Assignment / Mid Term Exam / End Term Exam*

12. Program Articulation Matrix

13. **List of courses offered under University open elective/Generic Elective**.

S.No.	Name of the Department	Semester	Course Code	Course Name	SWAYAM Course Name	Credits	Total No. Students may opt for this course
1.	**CSE**	ODD	TCS341	Python Programming for Computing	Programming in Python	3	60
2.	**CSE**	ODD	TCS521	User Interface Design	User Interface Design	3	60
3.	**ECE**	ODD	TEC 342	Foundations of Artificial Intelligence		3	60
4.	**EE**	ODD	TEE 307	Electrical Engineering Materials		3	30
5.	**Civil**	ODD	TCE 304	Building Materials and Construction equipment	As per availability	3	30
6.	**ME**	ODD	TME 311	Manufacturing Technologies		3	60
7.	**ME**	ODD	TME 509	Sustainable design and manufacturing		3	60
8.	**PE**	ODD	TPE 304	Introduction to Petroleum Operations		3	30
9.	**PE**	ODD	TPE 302	General Geology		3	30
10.	**BT**	ODD	TBT 504	Bioinformatics	Bioinformatics: Algorithms and Applications	3	10
11.	**AE**	ODD	TAS 305	Introduction to Aerospace Engineering	Introduction to Aerospace Engineering	3	60
12.	**BioTech.**	ODD	BSBT 503	Forensic Biology		3	20
13.	**MicroBio.**	ODD	BSCM 103	Microbes and Human Diseases		03	40
14.	**MicroBio.**	ODD	BSCM 304	Microbes in Human Welfare		03	40
15.	**FoodST**	ODD	BSCND 303	Menu Planning and Nutrition		3	40
16.	**MS**	ODD	BBA 304	E Commerce & Digital Marketing	Basics of Digital Marketing	3	30
17.	**MS**	ODD	BBA 304	Entrepreneur-ship: Theory & Practice	Entrepreneurship Essentials	3	30
18.	**HM**	ODD	BHM 103	Introduction To Room Division		3	60
19.	**HSS**	ODD	BEC 103	Introduction to Economics	-	3	30
20.	**HSS**	ODD	BPS 304	United Nations and Global Conflict	United Nations and Global Conflict	3	40
21.	**Commerce**	ODD	BCH 304	Investing In Stock Market		3	60

EVEN SEMESTER							
1.	**CSE**	EVEN	TCS492	Fundamental of Cyber Security	Introduction to Cyber Security	3	60
2.	**CSE**	EVEN	TCS421	Fundamental of Statistics and AI	Introduction to Statistics	3	60
3.	**ECE**	EVEN	TEC443	Introduction to Machine Learning	Introduction to Machine Learning	3	60
4.	**EE**	EVEN	TEE 402	Introduction to Electrical Energy Sources	-	3	30
5.	**Civil**	EVEN	TCE 404	Concrete Technology	As per availability	3	30
6.	**ME**	EVEN	TME 411	Principles of Industrial Engineering	As per availability	3	60
7.	**ME**	EVEN	TME 612	Product Engineering and Design Thinking	As per availability	3	60
8.	**PE**	EVEN	TPE 603	Natural Gas Engineering	Natural Gas Engineering	3	30
9.	**PE**	EVEN	TPE 624	City Gas Distribution		3	30
10.	**BT**	EVEN	TBT404	Bioanalytical Techniques	Analytical Techniques	3	10
11.	**BT**	EVEN	TBT406	Environmental Biotechnology	Environmental Biotechnology	3	10
12.	**AE**	EVEN	TAS 411	Introduction to UAS	UAV in Engineering Application	3	60
13.	**BioTech.**	EVEN	BSBT202a	Introductory Bioinformatics	Fundamentals of Bioinformatics	3	20
14.	**BioTech.**	EVEN	SBT405	Food Biotechnology	Food Science and Processing	3	20
15.	**MicroBio.**	EVEN	BSCM203	Microbiology for the non - Microbiologists		3	40
16.	**FoodST**	EVEN	BSCND 202	Introduction to Dietetics	Diet Management in Health and Disease	3	40
17.	**MS**	EVEN	BBA 203	Business Economics	Microeconomics for Business	3	30
18.	**MS**	EVEN	BBA 404 F	Managing Personal Finance		3	30
19.	**HSS**	EVEN	BPY 203	Emotional Intelligence	Emotional Intelligence	3	20
20.	**Commerce**	EVEN	BCH204	Macro Economics	Macro Economics	3	60
21.	**HM**	ODD	BHM 204	Uttarakhand Tourism		3	60

The list of course details to offer as Multidisciplinary/University open electives through SWAYAM.

Sl. No.	Semester	Course Code	Name of the Course
1.	ODD	UEO101	Intellectual Property Rights and Competition Law
2.	ODD	UEO102	Apparel Designing
3.	ODD	UEO103	ANIMATIONs
4.	ODD	UEO104	Introduction to Public Administration
5.	ODD	UEO105	Performing Arts & Allied Subjects
6.	ODD	UEO106	Creative Painting
7.	ODD	UEO107	Digital Marketing
8.	ODD	UEO108	Research Methodology
9.	ODD	UEO109	Sports Administration and Management
10.	ODD	UEO110	Wild Life and its Conservation

11.	ODD	UEO111	Entrepreneurship Development
12.	ODD	UEO112	Introduction to Film Studies
13.	ODD	UEO113	Research Academic Writing
14.	ODD	UEO114	Introduction to Research
15.	EVEN	UEE115	Roadmap for patent creation
16.	EVEN	UEE116	Thin Film Technology
17.	EVEN	UEE117	Sustainability Science
18.	EVEN	UEE118	Digital Media
19.	EVEN	UEE119	Advertising and Public Relations
20.	EVEN	UEE120	Introduction to Climate Change
21.	EVEN	UEE121	Communication and Extension for Sustainable Development
22.	EVEN	UEE122	Human Resource Development
23.	EVEN	UEE123	Skill Development of the youths and their Livelihood
24.	EVEN	UEE124	Research Ethics and Plagiarism
25.	EVEN	UEE125	Enhancing Study Skills
26.	EVEN	UEE126	Research and Publication Ethics (RPE)
27.	EVEN	UEE127	Introduction to Intellectual Property
28.	EVEN	UEE128	Yoga for Stress Management

14. Minor programs offered by the ECE Department for other Engineering Department.

Minor in Internet of Things (IoT)					
Semester	**Course Code**	**Course Name**	**SWAYAM Course Name**	**Credits**	**Total No. Students may opt for this course**
3rd	TEC 359	Fundamentals of Computer Organization		3	60
4th	TEC 491	Sensors and Signal Conditioning		3	
5th	TEC 591	Transducers, Actuators and Display Devices		3	
6th	TEC 659	Advanced Embedded Systems		3	
7th	TEC 759	Internet of Things and Its Applications		3	
8th	TEC 859		GPU Architectures and Programming	3	
Total Credits				**18**	

15. EXIT OPTIONS:

SEMESTER	Exit Option	Credits	Additional Credit	List of Exit Courses
I &II	Undergraduate Certificate in Electronics & Communication	41	6	1. Digital Circuits (Through Swayam). 2. Fundamentals of semiconductor Devices (Through Swayam).
III & IV	Undergraduate Diploma in Electronics & Communication	50	6	1. Electronic Systems Design: Hands-on Circuits and PCB Design with CAD Software (Through Swayam). 2. Scientific Computing using MATLAB (Through Swayam).
V & VI	Bachelor of Science in Electronics & Communication	43	6	1. C-Based VLSI Design (Through Swayam). 2. The Joy of Computing using Python (Through Swayam)
VII &VIII	B.Tech in Electronics & Communication Engineering	32	--	--
VII &VIII	B.Tech in Electronics & Communication Engineering with (Minor or Honours with Specialization)	32**	--	--

****Additional 18 credits are required to award (Minor/Honours with Specialization)**

16. List of Potential Recruiters for Employing Graduates in Electronics and Communication Engineering

· Microsoft Corporation
· Apps Associates
· Google
· Acuity Knowledge
· Adobe
· LTTS
· Amazon
· LTIMindtree
· Walmart Global Technology
· IBM
· Coforge
· Zscaler
· TCS
· Goldman Sachs
· Infosys
· Latent View
· Capgemini
· Bonami Software
· HCL
· Incture
· Informatica
· ANM
· Teradata
· Wissen Technologies
· EY India
· DXC
· 75Way Technologies
· Contata
· Global Logic
· Sopra Steria
· PWC
· MAQ Software
· Enquero Global
· Intel
· HSBC
· Hexaware Technology
· Accenture
· Yamaha
· Accolite
· JSW
· Cognizant
· Autopay
· Vinculum
· Nineleaps
· Atlassian
. American Express
. Airbus India
. Salesforce
. Tally India
. Lowes India
. Morgan Stanley
. AbinBevGCC
. Flipkart
. Siemens
. L&T Infotech
. Deloitte
. Samsung Electronics
. Godrej Electronics
. Mentor Graphics
. STMicroelectronics and Many more