GITAM
(DEEMED TO BE UNIVERSITY)
(Estd. u/s 3 of the UGC Act, 1956)
BENGALURU ❋ HYDERABAD ❋ VISAKHAPATNAM
NAAC Accredited with A+ Grade

REGULATIONS AND SYLLABUS

of

Master of Technology

in

Radio Frequency and Microwave Engineering

(w.e.f. 2019-20 admitted batch)

A University Committed to Excellence

M.Tech. in Radio Frequency and Microwave Engineering

REGULATIONS
(w.e.f. 2019-20 admitted batch)

1. ADMISSION

Admission into M.Tech. in Radio Frequency and Microwave Engineering program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1 A pass in B.E./B/Tech./AMIE in ECE or its equivalent.

2.2 Admissions into M.Tech. will be based on the following:

(i) Score obtained in GAT (PG), if conducted.
(ii) Performance in Qualifying Examination / Interview.
(iii) Candidates with valid GATE score shall be exempted from appearing for GAT (PG).

2.3 The actual weightage to be given to the above items will be decided by the authorities at the time of admissions.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from 2015-16 admitted batch and revised with effect from academic year 2019-20 in order to promote:

- Student centered Learning
- Activity based learning
- Students to learn courses of their choice
- Cafeteria approach

3.2 Learning objectives and outcomes are outlined for each course to enable a student to know what he/she will be able to do at the end of the program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

i) Core Courses (compulsory) which give exposure to a student in core subjects related area.

ii) Program Electives.

iii) Open Electives

iv) Mandatory and Audit Courses

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture / Tutorial hour per week.
- One credit for two hours of Practicals per week.

4.4 The curriculum of the four semesters M.Tech. program is designed to have a total of 68 credits for the award of M.Tech. degree

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in the academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the semester-end examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 65% and 74% on genuine grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and semester-end examination (60 marks).

8.2 A student has to secure a minimum of 40% in any theory course in the two components (ref. 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Practical/ Project Work/ Viva voce/ Seminar etc. course are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

8.4 Audit courses are assessed through continuous evaluation for satisfactory or not satisfactory only.

No credits will be assigned.

Table 1: Assessment Procedure

S.No.	Component of Assessment	Marks Allotted	Type of Assessment	Scheme of Evaluation
1	Theory Courses	40	Continuous Evaluation	i) Thirty (30) marks for mid Semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration.
		60	Semester-end Examination	ii) Ten (10) marks for Quizzes, Assignments and Presentations. Sixty (60) marks for Semester-end examinations

	Total	100		
2	Practical Courses	100	Continuous Evaluation	i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.
3	Technical Seminar (II Semester)	100	Continuous Evaluation	Through five periodic seminars of 20 marks each
4	Project Work (III Semester)	100	Continuous Evaluation	i) Forty (40) marks for periodic assessment on originality, innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation for defending the project, before a panel of examiners. iii) Thirty (30) marks for final report presentation and viva-voce, by a panel of examiners*.
5	Project Work (IV Semester)	50	Continuous Evaluation	i) Twenty (20) marks for periodic assessment on originality innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Fifteen (15) marks for mid-term evaluation for defending the project, before a panel of examiners*. iii) Fifteen (15) marks for interim report presentation and viva-voce.
		50	Semester-end Examination	Fifty (50) marks for final project report and viva-voce examination assessed by external examiners.
	Total	100		

6	Audit Courses	100	Continuous Evaluation	Audit courses are assessed for PASS or FAIL only. No credits will be assigned to these courses. If a student secures a minimum of 40 out of 100 marks during continuous evaluation, he / she will be declared PASS, else FAIL. PASS grade is necessary to be eligible to get the degree

**Panel of Examiners shall be appointed by the concerned Head of the Department*

9. PROVISION FOR ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

9.1 If a student is not satisfied with his/her grade, the student can apply for answer book verification on payment of prescribed fee for each course within one week after announcement of results.

9.2 After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of results, which will be valued by two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is successful in the appeal by securing a better grade.

10. SUPPLEMENTARY AND SPECIAL EXAMINATIONS

10.1 The odd semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

10.2 The even semester supplementary examinations will be conducted after conducting regular odd semester examinations during October/November.

10.3 A student who has secured 'F' Grade in Project work shall have to improve his/her work and reappear for viva-voce after satisfactory completion of work approved by panel of examiners.

10.4 A student who has completed period of study and has "F" grade in final semester courses is eligible to appear for special examination.

11. MASSIVE OPEN ONLINE COURSES (MOOCs)

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses up to first semester are permitted to register for MOOCs in second semester up to a maximum of 6 credits from program elective / open elective/audit courses. However the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency will be decided by the respective Board of Studies (BoS).

12. GRADING SYSTEM

12.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

Sl.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab (Absent)	0	-

12.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5.0 for a Pass in the semester.

13. GRADE POINT AVERAGE

13.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

Where, C = number of credits for the course,
G = grade points obtained by the student in the course.

13.2 The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester.

13.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for Award of Class

Class	CGPA Required
First Class with Distinction	$\geq$ 8.0*
First Class	$\geq$ 6.5
Second Class	$\geq$ 5.5
Pass Class	$\geq$ 5.0

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in the first attempt.

14. ELIGIBILITY FOR AWARD OF THE M.Tech. DEGREE

14.1 Duration of the program: A student is ordinarily expected to complete the M.Tech. Program in four semesters of two years. However, a student may complete the program in not more than four years including study period.

14.2 However the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

14.3 A student shall be eligible for award of the M.Tech. Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and project works.

b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated period.

c) Has no dues to the Institute, Hostels, Libraries, NCC / NSS etc, and

d) No disciplinary action is pending against him / her.

15. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

M. Tech. in Radio Frequency and Microwave Engineering

Department of Electronic and Communication Engineering
w.e.f. 2019-20 admitted batch

I Semester

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC701	RF Components and Circuit Design	PC	3	0	0	3
2	19EEC703	Antenna Analysis and Design	PC	3	0	0	3
3	19EEC705	EMI & EMC Techniques	PC	3	0	0	3
4	19EEC7XX	Program Elective I	PE	3	0	0	3
5	19EEC7XX	Program Elective II	PE	3	0	0	3
6	19EMC741	Research Methodology and IPR	MC	2	0	0	2
7	19EEC721	Microwave Measurements Laboratory	PC	0	0	4	2
8	19EEC723	Antenna Measurements Laboratory	PC	0	0	4	2
9	19EAC7XX	Audit Course I	AC	2	0	0	0
							21

II Semester

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC702	Microwave Devices and Integrated Circuits	PC	3	0	0	3
2	19EEC7XX	Program Elective III	PE	3	0	0	3
3	19EEC7XX	Program Elective IV	PE	3	0	0	3
4	19EEC7XX	Program Elective V	PE	3	0	0	3
5	19EOE7XX	Open Elective	OE	3	0	0	3
6	19EEC792	Technical Seminar	PC	0	0	4	2
7	19EEC722	Microwave Circuit Design Laboratory	PC	0	0	4	2
8	19EEC724	Antenna Design and Simulation Laboratory	PC	0	0	4	2
9	19EAC7XX	Audit Course II	AC	2	0	0	0
							21

III Semester

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC891	Project Work I	PW	0	0	26	13
							13

IV Semester

S. No	Course Code	Course Title	Category	L	T	P	C
2	19EEC892	Project Work II	PW	0	0	26	13
							13

Number of Credits

Semester	I	II	III	IV	Total
Credits	21	21	13	13	**68**

AUDIT COURSES I and II

S.No	Course Code	Course Title	Category	L	T	P	C
1	19EAC741	English For Research Paper Writing	AC	2	0	0	0
2	19EAC742	Disaster Management	AC	2	0	0	0
3	19EAC743	Sanskrit for Technical Knowledge	AC	2	0	0	0
4	19EAC744	Value Addition	AC	2	0	0	0
5	19EAC745	Constitution of India	AC	2	0	0	0
6	19EAC746	Pedagogy Studies	AC	2	0	0	0
7	19EAC747	Stress Management by Yoga	AC	2	0	0	0
8	19EAC748	Personality Development through Life Enlightenment Skills	AC	2	0	0	0
9	19EAC750	Developing Soft Skills and Personality	AC	2	0	0	0

OPEN ELECTIVE

S.No	Course Code	Course Title	Category	L	T	P	C
1	19EOE742	Business Analytics	OE	3	0	0	3
2	19EOE744	Industrial Safety	OE	3	0	0	3
3	19EOE746	Operations Research	OE	3	0	0	3
4	19EOE748	Cost Management of Engineering Projects	OE	3	0	0	3
5	19EOE752	Waste to Energy	OE	3	0	0	3

PROGRAM ELECTIVES

Program Elective I

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC741	RF Receiver Design And Wireless Applications	PE	3	0	0	3
2	19EEC743	Microwave Networks	PE	3	0	0	3
3	19EEC745	Satellite Communication Systems	PE	3	0	0	3

Program Elective II

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC747	Smart Antennas for Mobile Communication	PE	3	0	0	3
2	19EEC749	Microwave Measurements	PE	3	0	0	3
3	19EEC751	Fiber Optic Communications	PE	3	0	0	3

Program Elective III

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC742	Phased Array Antennas	PE	3	0	0	3
2	19EEC744	Computational Methods in Electromagnetics	PE	3	0	0	3
3	19EEC746	Optical Networks	PE	3	0	0	3

Program Elective IV

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC748	RF and Microwave MEMs	PE	3	0	0	3
2	19EEC750	Radar Systems	PE	3	0	0	3
3	19EEC752	Mobile communications	PE	3	0	0	3

Program Elective V

S. No	Course Code	Course Title	Category	L	T	P	C
1	19EEC754	Global Positioning Systems	PE	3	0	0	3
2	19EEC756	Wireless Channels and UWB Radio	PE	3	0	0	3
3	19EEC758	Wireless Sensors Networks	PE	3	0	0	3

19EEC701: RF COMPONENTS AND CIRCUIT DESIGN

L	T	P	C
3	0	0	3

The objective of this course is to present the concepts of design and analysis of modern RF and wireless communication integrated circuits. In this course mainly concentrated on microwave frequency circuits, the way of design, different applications like RADAR, Navigation, RF Identification. There after different RF electronic components and some parameters calculation based on Smith Chart. Finally, amplifier and oscillator circuit design at RF frequency.

Course Objectives:

- To understand Basic RF frequency advantages and circuit design process.
- To impart the knowledge of basic resonant and impedance matching circuits
- To understand the basic calculations using smith chart.
- To understand RF amplifiers and their design process.
- To understand RF Oscillators and their design process.

Unit I **8L**

Introduction to RF and Microwave concepts and applications: Introduction, reasons for using rf/microwaves, RF/microwave applications, radio frequency waves, RF and microwave circuit design, the unchanging fundamentals versus the ever-evolving structure, general active circuit block diagrams

Learning Outcomes: The students will be able to

- understand the concept of basic RF/ Microwaves, applications (L1).
- explain the RF and Microwave circuit design (L2).
- analyze the unchanging fundamentals versus the ever-evolving structure (L4).
- construct General active circuit block diagrams (L3).

Unit II **8L**

RF Electronics Concepts: Introduction, RF/Microwaves versus DC or low AC signals, EM spectrum, wave length and frequency, introduction to component basics, resonant circuits, analysis of a simple circuit in phasor domain, impedance transformers, RF impedance matching, three element matching.

Learning Outcomes: The students will be able to

- apply basic RF electronic concepts to circuit design (L3).
- distinguish difference DC or low AC signals (L1).
- demonstrate Resonant Circuits Impedance transformers, impedance matching (L2).

Unit III **8L**

Smith Chart and its Applications: Introduction, a valuable graphical aid the smith chart, derivation of smith chart, description of two types of smith charts, smith charts circular scales, smith charts radial scales, the normalized impedance-admittance (ZY) smith chart introduction, applications of the smith chart, distributed circuit applications, lumped element circuit applications.

Learning Outcomes:

After completion of this unit the student will be able to

- state valuable graphical aid the smith chart, Different types (L1).
- describe Smith charts circular scales, normalized impedance-admittance (L2).
- determine the (ZY) (L3).
- analyze lumped element circuit and its applications(L5).

Unit IV **8L**

RF and Microwave Amplifiers: Introduction, types of amplifiers, small signal amplifiers, design of different types of amplifiers, multistage small signal amplifier design, high-power amplifiers, large signal amplifier design, microwave power combining/dividing techniques, signal distortion due to inter modulation products, multistage amplifiers, large signal design.

Learning Outcomes:

After completion of this unit the student will be able to

- state Types of amplifiers, Multistage small signal amplifier (L1).
- explain Microwave power combining/dividing techniques (L2).
- investigate Signal distortion due to inter modulation products (L3).
- explain multistage amplifiers, large signal design(L5).

Unit V **8L**

RF and Microwave Oscillator Design: Introduction, oscillator versus amplifier design, oscillation conditions: Two port NR oscillators, a special case: One port NR oscillator, condition of stable oscillation, design of transistor oscillators, generator-tuning networks: Fixed frequency oscillators, frequency tunable oscillators

Learning Outcomes:

After completion of this unit the student will be able to

- distinguish between Oscillator and amplifier design (L1).
- analyze the operations of Two port NR oscillators(L4).

- explain Oscillation conditions, transistor oscillators (L2).
- construct Generator-tuning networks (L3).

Text Books:

1. Mathew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Prentice hall,2001.
2. Joseph Helszain, “Microwave Engineering, Active and Non-Reciprocal Circuits”, McGraw Hill International Edition, 1992.

Course Outcomes:

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

- to understand difference DC or low AC signals (L1).
- to understand different types smith charts, RF and Microwave circuit design (L2).
- construct Multi stage small signal amplifier, Generator-tuning networks (L3).
- determine the normalized impedance-admittance (L3).
- to understand the Signal distortion due to inter modulation products (L4).

19EEC703: ANTENNA ANALYSIS AND DESIGN

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles of antennas. The first unit covers antenna fundamentals, second unit gives an idea about vector potentials, third unit deals with wire antennas, fourth unit gives an idea about antenna arrays and the last unit cover the antenna synthesis.

Course Objectives:

- To learn the basic parameters of an antenna and its radiation mechanism.
- To understand the Vector potentials and radiation integrals.
- To understand the radiation characteristics of various antennas.
- To understand the radiation pattern of an array (uniform and non-uniform) and apply the principle of multiplication of patterns.
- To learn the design aspects of various antennas.

Unit I **8L**

Antennas and Fundamental Parameters of Antennas: Introduction, Fundamentals of Antennas, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation. Reciprocity and Reaction Theorems.

Learning Outcomes:

After completion of this unit the student will be able to

- understand antenna concepts(L2).
- get the knowledge of antenna properties and mechanisms for radiation from general current sources in free space(L1)
- determine the radiation patterns (in principal planes) of antennas(L3)

Unit II **8L**

Radiation Integrals and Auxiliary Potential Functions: Introduction, The Vector Potential A for an Electric Current Source J, The Vector Potential F for a Magnetic Current Source M, Electric and Magnetic Fields for Electric (J) and Magnetic (M) Current Sources, Far-Field Radiation.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the concept of radiation through mathematical formulation (L1).
- analyze the radiation mechanisms of antennas (L2).
- discriminate between antennas on the basis of their electrical performance(L4).

Unit III **8L**

Wire and practical antennas: Introduction, Dipole antennas, Traveling Wave Antennas, Broadband Antennas, Parabolic Reflector, Linear Elements Near or on Infinite Perfect Conductors, Ground Effects, Small Circular Loop, Circular Loop of Constant Current, Circular Loop with Non uniform Current.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the basic principles of all types of antennas (L2).
- analyze the most important antenna types and calculate radiation patterns of the most common antenna types (L1).
- plot the characteristics of wire and aperture antennas (L3).
- design and analyze wire antennas (L4).

Unit IV **8L**

Arrays: Introduction, N Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, Design Procedure, Rectangular-to-Polar Graphical Solution, N Element Linear Array: Uniform Spacing, Non uniform Amplitude, Super directivity, Planar Array, Design Considerations, Circular Array.

Learning Outcomes:

After completion of this unit the student will be able to

- design and analyze antenna arrays (L1).
- become proficient with analytical skills for understanding practical antennas (L4).
- get In-depth knowledge for the construction of resonant antennas, array antennas (L3).

Unit V **10L**

Antenna Synthesis and Continuous Sources: Introduction, Continuous Sources, Schelkunoff Polynomial Method, Fourier Transform Method, Woodward-Lawson Method, Taylor Line-Source (Tschebyscheff-Error), Taylor Line-Source (One-Parameter), Triangular, Cosine, and Cosine-Squared Amplitude Distributions, Line-Source Phase Distributions, Continuous Aperture Sources.

Learning Outcomes:

After completion of this unit the student will be able to

- analyze different types of antennas designed for various frequency ranges (L3).
- design antenna for various applications (L2).
- get the knowledge of modern antenna synthesis of different antennas (L5).

Textbook

1. Balanis, C.A., Antenna Theory: Analysis and Design, 3/e, John Wiley and Sons, 2005

References

1. Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2/e, Prentice Hall of India. 1993
2. Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2/e, John Wiley and Sons, 1998
3. Elliot, R.S., "Antenna Theory and Design", Revised edition, Wiley- IEEE Press. 2003

Course Outcomes:

After completion of this course the student will be able to

- understand all the required parameters of antennas (L2).
- gain the knowledge about vector potentials and able to apply for different radiation problems (L3).
- calculate radiation parameters of basic antennas (L1).
- classify and analyze different antenna arrays (L5).
- get knowledge about design concepts of different antennas using synthesis techniques (L4).

19EEC705: EMI AND EMC TECHNIQUES

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles and building blocks of Electromagnetic environment and concepts of Electromagnetic interference and Compatibility. The first three units cover the electric circuits tend to EMI and EMC, the circuits for measure the quality of electric Circuits and equipment's. The last two units cover testing procedure and sustainability techniques for the protection of electric equipment's and devices and their Standards.

- To familiarize the basic EMI and EMC problems in electrical and electronic circuits.
- To explain the concepts of EMI and EMC in electrical circuits and their characteristics.
- To introduce the importance of measuring equipment's.
- To impart the knowledge about the characteristics, working principles and applications of
- Filters and impedance matching techniques, grounding and shielding measures and design aspects.
- To expose basic concepts of standards and regulations.

Unit I **8L**

Natural and nuclear sources of EMI / EMC: Electromagnetic environment, concepts of EMI and EMC and definitions, an overview of EMI / EMC, celestial electromagnetic noise, lightning discharge, electrostatic discharge, electromagnetic pulse.

Learning Outcomes:
After completion of this unit the student will be able to

- state EMI and EMC (L1).
- identify and analyze the root cause of EMI and EMC in a circuit (L1).
- predict the behavior of a circuit (L2).
- determine the current, voltage and power in the given circuit (L4).
- apply various techniques to analyze an electric circuit (L3).

Unit II **8L**

EMI from apparatus, circuits and open area test sites: Electromagnetic emissions, noise from relays and switches, nonlinearities in circuits, passive intermodulation, transients in power supply lines, electromagnetic interference. Open area test sites and measurements, open-area test site, normalized site attenuation, antenna factor measurement.

Learning Outcomes:

After completion of this unit the student will be able to

- describe the root cause of EMI and EMC in the Circuits (L1).
- analyze EMI and EMC in different power lines (L4).
- demonstrate the performance characteristics of different types of Circuit elements (L3).
- explain types of Testing methods (L2).
- estimate the noise levels due to EMI and EMC of electrical circuits (L2).

Unit III **8L**

Radiated and conducted interference measurement: Anechoic chamber, TEM cell, giga-Hertz TEM Cell, comparison of test facilities, characterization of conduction currents /voltages, conducted EM noise on power lines, conducted EMI from equipment, immunity to conducted EMI, detectors and measurements.

Learning Outcomes:

After completion of this unit the student will be able to

- describe the constructional details of measuring equipment (L1).
- demonstrate radiated test facilities (L3).
- discuss about Anechoic and Tem cell test Chambers (L2).
- explain the working principle of three Testing Cells (L5).
- estimate losses and efficiency of EM power lines due to EMI (L2).

Unit IV **8L**

Grounding, shielding, bonding and EMI filters: EMC technology, grounding, shielding, electrical bonding, characteristics of filters, impedance mismatch effects, lumped element LPF, HPF, BPF, BRF, power lines filter design.

Learning Outcomes:

After completion of this unit the student will be able to

- describe the device structure and operation to protect the circuit from EMI and EMC (L1)
- discuss characteristics of different filters (L2)
- explain the use of grounding, shielding and bonding in electronic circuits(L2)
- describe the construction and operation of power line design (L1)
- explain the use of lumped elements and filter circuits (L2)

Unit V **8L**

Cables, connectors, components and EMC standards: EMI suppression cables, EMC connectors, EMC gaskets, isolation transformers, opt isolators, standards for EMI/EMC, MIL-STD-461/462, IEEE/ANSI standards, CISPR/IEC standards, FCC regulations.

Learning Outcomes:

After completion of this unit the student will be able to

- list the characteristics of a Cables and standard EMC circuit elements (L1)
- explain the standards for EMI/EMC (L2)

Text Book:

1. V.P. Kodali, Engineering Electromagnetic Compatibility, 2/e, Wiley-IEEE Press, 2001.

References

1. Electromagnetic Interference and Compatibility IMPACT series, IIT Delhi, Units1- 9.
2. C. R. Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, 2013.

Course Outcomes:

The completion of the course, the student is able to

- find the source of Electromagnetic interference(L2).
- pinpoint the defect in the circuit Design that cause the EM noise(L1).
- analyse the test conditions for the EUT(L4).
- explain the measurements with help of testing procedures(L3).
- predict the proper grounding, Shield and safety equipment's(L5).

19EEC741: RF RECEIVER DESIGN AND WIRELESS APPLICATIONS

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles and building blocks of RF Receiver Design and Wireless Applications. The first three units cover the design and performance issues of wireless system, microwave amplifier design, noise and distortion in microwave systems. The last two units cover Mixers, Switches, Oscillators and frequency synthesizers of microwave systems.

Course Objectives:

- To develop an ability, enthusiasm critical thinking in wireless systems and design issues
- To develop an ability to analyze noise and distortion of microwave systems.
- To develop an inclination towards electronics system design and manufacturing.
- Elaborate the design strategies of Mixers at various levels and its analysis.
- To investigate the device models for microwave switches, RF oscillators and frequency synthesizers.

Unit I **8L**

Introduction to wireless systems:
Classification of wireless systems; Design and performance issues: Choice of operating frequency, multiple access and duplexing, circuit switching versus packet switching, propagation, radiated power and safety; Cellular telephone systems and standards.

Learning Outcomes:

After completion of this unit the student will be able to

- identify the wireless systems and their design issues(L2).
- predict the operating frequency and utilization of multiple access techniques(L4).
- distinguish between circuit switching and packet switching(L1).
- understand the radiated power mechanism(L3).
- identify cellular telephone systems and their standards(L5).

Unit II **8L**

Noise and distortion in microwave systems: Basic threshold detection, noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, two-port networks, mismatched transmission lines and Wilkinson power dividers; Dynamic range and inter-modulation distortion.

Learning Outcomes:

After completion of this unit the student will be able to

- analyze the noise temperature and noise figure of a lossy transmission line(L1).
- demonstrate the noise figure of cascaded systems(L3).
- investigate the noise figure of the two-port networks(L5).

- analyze the noise figure behavior with Wilkinson power divider(L2).
- analyze the distortion with inter-modulation systems(L4).

Unit III **8L**

Microwave amplifier design: Comparison of active devices such as BJT, MOSFET, MESFET, HEMT, and HBT; Circuit models for FETs and BJTs; Two-port power gains; Stability of transistor amplifier circuits; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain, low-noise amplifier design, design of class-A power amplifiers.

Learning Outcomes:

After completion of this unit the student will be able to

- compare various active devices(L1).
- analyze circuit models for microwave amplifier design(L3).
- analyze the microwave amplifier design using scattering-parameters(L2).
- design amplifier with adjustable and stable gain(L5).
- design power amplifiers(L4).

Unit IV **8L**

Mixers: Mixer characteristics: Image frequency, conversion loss, noise figure; Devices for mixers: p-n junctions, schottky barrier diode, FETs; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.

Learning Outcomes:

After completion of this unit the student will be able to

- investigate the characteristics of a Mixer(L3).
- identify and model the devices for mixers(L5).
- analyze small-signal characteristics and switching model(L1).
- describe FET mixers(L2).
- demonstrate balanced and image reject mixers(L4).

Unit V **8L**

Switches: Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches. Oscillators and Frequency Synthesizers: General analysis of RF oscillators, transistor oscillators, voltage-controlled oscillators, dielectric resonator oscillators, frequency synthesis methods, analysis of first and second order phase-locked loop, oscillator noise and its effect on receiver performance.

Learning Outcomes:

After completion of this unit the student will be able to

- identify the devices for microwave switches(L4).
- demonstrate the types of switches(L2).
- analyze the RF oscillators and Frequency synthesizers(L5).
- analyze the first and second order phase-locked loops(L1).
- explain the oscillator noise and its effect on receiver performance(L1).

Text Book(s)

1. Pozar, D.M. Microwave and RF Design of Wireless Systems, John Wiley & Sons. 2001

References

1. Gonzalez, G., Microwave Transistor Amplifiers: Analysis and Design, 2/e., Prentice- Hall. 2008
2. Bahl, I. and Bhartia, P., Microwave Solid State Circuit Design, 2/e., John Wiley & Sons. 2003
3. Chang, K., Bahl, I. and Nair, V., RF and Microwave Circuit and Component Design for Wireless Systems, Wiley Interscience. 2002

Course Outcomes:

Successful completion of the course, the student will be able to

- analyze the behavior of wireless systems(L2).
- analyze the noise and distortion in microwave systems(L1).
- design the microwave amplifier with maximum, stable and adjustable gain(L3).
- analyze microwave mixers and switching models(L2).
- analyze the RF oscillators and frequency synthesizers and their noise behavior(L5).

19EEC743: MICROWAVE NETWORKS

L	T	P	C
3	0	0	3

The objective of this course is to present the concepts of microwave networks. This course mainly concentrated on designing various impedance matching techniques for maximum power transfer. Scattering parameters for various circuits such as Tee junctions, ferrite devices and applications of various microwave passive components have been analysed. Field analysis of resonant circuits and designing of narrow band and wide band filters is described.

Course Objectives:

- To understand and gain complete knowledge about microwave components.
- To provide knowledge on microwave components and its S parameters.
- To provide the basic concepts of microwave filters and MICS.
- To understand the concept of faraday rotation and its application on various components.
- To impart the knowledge of designing various types of filters.

Unit I **8L**

Microwave Circuits: One port junction, Terminal voltages and currents in multi port junctions, Poynting's energy theorem, Normalized waves and scattering matrix, Properties of [S] matrix, Wave amplitude transmission matrix [A], Impedance matching techniques: Quarter-wave and Tapered line Impedance transformers.

Learning Outcomes:

After completion of this unit the student will be able to

- calculate the power distribution in microwave components(L2).
- analyze microwave circuits using scattering parameters(L1).
- understand various impedance matching techniques(L3).

Unit II **8L**

Microwave Waveguide Components: Microwave junctions, Bends, Scattering matrix E and H plane tee junctions, Magic-T, Applications of Magic-T, Microwave propagation in ferrites, Principles of Faraday rotation, Gyrator, Isolator and Circulator.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the operation of microwave waveguide components(L2).
- calculate the power distribution in microwave waveguide components(L3).
- calculate scattering parameters of various Tee junctions(L4).

Unit III **8L**

Waveguide Components, Mode transducers, Waveguide discontinuities, Terminations, Attenuators and Phase shifters, Rotary joints, Mechanical and gas type switches.

Learning Outcomes
After completion of this unit the student will be able to

- understand the operation of passive waveguide components(L2).
- demonstrate the use of mechanical and gas type switches(L3).
- describe the operation of attenuator and phase shifter(L1).

Unit IV **8L**

Microwave Passive Components: Wave meters, Attenuators, Directional coupler, Scattering matrix of directional coupler, Coaxial and Strip line components: Terminations, Connectors and Transitions, Attenuators and phase shifters, MICS.

Learning Outcomes
After completion of this unit the student will be able to

- understand the operation of passive waveguide components(L2).
- calculate scattering parameters of Directional coupler(L1).
- demonstrate Directional coupler, MICS(L4).

Unit V **8L**

Microwave Resonators and Filters: Review of resonant circuits, Principles of microwave resonators, Field analysis of cavity resonators, Narrow band microwave filters, Wideband microwave filters, Some applications, Introduction to YIG filter.

Learning Outcomes
After completion of this unit the student will be able to

- understand the operation of microwave resonators and filters(L1).
- distinguish Narrow band and wide band filters(L4).
- design various filters(L2).

Text Book(s)

1. R.E. Collins, Foundations of Microwave Engg, 2/e, Tata Mcgraw Hill, 2002
2. P.A. Rizzi, Microwave Engineering, Pearson Education, 2007
3. Annapurna Das and Sisir K. Das, Microwave Engineering, 2/e, Tata Mcgraw Hill, 2008.
4. M. Kulkarni," Microwave and Radar Engineering ", Umesh Publications, 2003.

Course outcomes:

Successful completion of course, the student will be able to

- Understand the basics of Microwave Circuits and devices(L2).
- Analyze microwave circuits using scattering parameters(L1).
- Calculate the power distribution in microwave waveguide components(L4).
- Describe the operation of attenuator and phase shifter(L3).
- Distinguish Narrow band and wide band filters(L5).
- Design various filters(L2).

19EEC745: SATELLITE COMMUNICATION SYSTEMS

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles and applications of the satellite system. The first three units cover satellite system, frequency allocation, orbits of satellite systems link design and modulation techniques. The last two units cover Satellite earth station and networks.

Course Objective:

- To provide fundamentals of satellite communication and its applications.
- To provide an overview of Satellite orbits, design process and subsystems.
- To introduce important modulation techniques used in satellite communication systems.
- To provide satellite system configuration and to introduce GPS system
- To appreciate the contribution of Satellite communication to the overall technological growth.
- To understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used.

Unit I **8L**

Introduction: History, the Indian scenario, frequency allocation, basic satellite systems, satellite orbits, geostationary orbit, orbital parameters and perturbations, longitudinal changes, inclination changes, eclipse.

Learning outcomes:

After completion of this unit the student will be able to

- the students are able to understand the basics of satellite communication(L1).
- the students are become familiar with satellites and its application(L4).
- students are enable to known the satellite orbits and orbital parameters(L5).

Unit II **8L**

Satellite link design and Space craft: Basic link analysis, attenuation and interference effects, uplink, downlink and satellite link design, space craft: lifetime and reliability, subsystems of satellite – transponder, antenna, attitude control, propulsion system, telemetry, tracking & control, power system, thermal control system and structure subsystems.

Learning outcomes:

After completion of this unit the student will be able to

- design and analysis of satellite links for various types of services and familiarity with terms and techniques related to performance evaluation and the availability of such links(L1).
- acquired the background to understand the principles of analysis and design of satellite systems. To analyze and design of system-level elementary links and satellite orbits(L2).
- familiar with satellites sub systems(L4).

Unit III **8L**

Modulation and Multiplexing techniques: Introduction, signal sources, analog transmission systems, frequency division multiplexing, frequency modulation, digital transmission systems, source coding, digital modulation and demodulation, TDM.

Learning outcomes:

After completion of this unit the student will be able to

- discriminate between analog and digital transmission systems(L2).
- analyze various analog and digital wave modulation and demodulation techniques(L3).
- distinguish between FDM, TDM multiplexing techniques(L1).

Unit IV **8L**

Earth station: Introduction, design considerations, general configuration, antenna systems, feed system, tracking system, high power amplifier, low noise amplifier, earth station equipment. Introduction to Global Navigation Satellite Systems: GPS, GLONASS, GALILEO

Learning outcomes:

After completion of this unit the student will be able to

- know the satellite communication equipment like different types of earth stations, transmitter and receivers(L2)
- know the design considerations of antenna system, tracking system and other internal systems(L4)
- know Satellite navigation & the global positioning system(L3).

Unit V **8L**

Satellites in Networks: Introduction, Bandwidth, Network Basics, Asynchronous Transfer Mode (ATM), ATM over Satellite, The Internet, Internet Layers, The TCP Link Satellite Links and TCP, Enhancing TCP Over Satellite Channels Using Standard Mechanisms (RFC-2488), Requests for Comments, Split TCP Connections, Asymmetric Channels, Proposed Systems

Learning outcomes:

After completion of this unit the student will be able to

- understand network basics(L2).
- know the different types of satellite networks(L3).
- hnow the satellite internet protocols (TCP) and its layer and channel utilization(L1).

Text Books:

1. T. Pratt and S. W. Bostian, Satellite Communication, 2/e, John Wiley and Sons, 2008.
2. Satellite Communications, Dennis Roddy, 4/e, McGraw-Hill International edition, 2006.
3. D. C. Agarwal, Satellite Communication, 4/e, Khanna Publishers, 2002.

Reference Books:

- Dharma Raj Cheruku, Satellite Communication, IK International Publishing House, New Delhi, 2010.

Course outcomes:

Successful completion of course, the student will be able to

- understand the basics of satellite communication system(L1).
- uesign the satellite communication links(L3).
- analyze the frequency allocation of satellites systems(L5).
- design the satellite subsystem and earth station(L4).
- demonstration of various applications of satellites(L2).

19EEC747: SMART ANTENNAS FOR MOBILE COMMUNICATION

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles of smart antennas and antenna systems. The first three units cover antennas, antenna arrays in smart antenna systems. The last two units cover techniques to improve the performance of an antenna system.

Course objectives:

1. To impart knowledge about the performance parameters of antenna arrays in mobile communications.
2. To introduce configuration and architecture of antennas in a smart antenna system.
3. To expose various smart antenna systems.
4. To familiarize CDMA techniques for a smart antenna system.
5. To explain the concept of performance improvement in smart antenna systems.

Unit I **8L**

Applications of antenna arrays to mobile communications: Performance improvement, feasibility, and system considerations (Complete contents of reference 1) application of antenna arrays to mobile communications, beam-Forming and direction-of-arrival considerations.

Learning outcomes:
After completion of this unit student will be able to

- improve the performance of an antenna system(L2).
- enhance design considerations of a smart antenna system(L1).
- arrays in beam forming and direction of arrival considerations(L3).

Unit II **8L**

Introduction to Smart antennas: Spatial processing for wireless systems, key benefits of smart antennas, smart antenna introduction, smart antenna configuration, SDMA, architecture of smart antenna systems.

Learning outcomes:
After completion of this unit student will be able to

- give the benefits of smart antennas(L1).
- describe a smart antenna configuration(L3).
- explain the architecture of antenna systems(L2).

Unit III **8L**

Smart antenna systems: The vector channel impulse response and the spatial signature, spatial processing receivers, fixed beam forming networks, switched beam systems, adaptive antenna

systems, wideband smart antennas, spatial diversity, diversity combining, and sectoring, digital radio receiver techniques and software radios for smart antennas, transmission beam forming.

Learning outcomes

After completion of this unit student will be able to

- explain spatial processing receivers(L1).
- describe beam forming and switched beam systems(L3)
- analyze techniques for smart antennas(L1)

Unit IV **8L**

Smart antennas techniques for CDMA: Non-Coherent CDMA spatial processors, coherent CDMA spatial processors and the spatial processing rake receiver, multi-user spatial processing, dynamic re-sectoring using smart antennas, downlink Beam forming for CDMA.

Learning outcomes

After completion of this unit student will be able to

- analyze coherent and non-coherent CDMA spatial processors(L4).
- understand spatial processing rake receiver(L1).
- explain multi-user spatial processing, dynamic re-sectoring and downlink beam forming(L2).

Unit V **8L**

CDMA system range and capacity improvement using spatial filtering: Range extension in CDMA, single cell systems with spatial filtering at the IS-95 base station, reverse channel performance of multi-cell systems with spatial filtering at the base station, reverse channel spatial filtering at the WLL subscriber unit, range and capacity analysis using smart antennas – A vector based approach.

Learning outcomes:

- describe range extension in CDMA and spatial filtering at base station(L1).
- discuss reverse channel performance of multi-cell systems at base station and at subscriber(L3).
- explain vector based approach for analysis of range and capacity analysis(L2).

Text Books:

1. T.S. Rappaport and J.C. Liberti, Smart Antennas for Wireless Communications, Prentice Hall, 1999
2. Tapan K Sarkar, Smart Antennas ,IEEE Press, John Wiley & Sons Publications,2003
3. L.C.Godara, Applications of antenna arrays to mobile communications, Part I: Performance improvement, feasibility, and system considerations, Proc. IEEE, vol. 85, no.7, pp.1031-1060, 1997.

Course Outcomes:

At the end of the syllabus student will be able to

- Give design considerations of a smart antenna system(L3).
- Explain the architecture and benefits of a smart antenna system(L5).
- Describe beam forming and switched beam techniques(L1).
- Analyze various CDMA processors(L2).
- Discuss the performance of multi-cell systems at subscriber and at base station(L4).

19EEC749: MICROWAVE MEASUREMENTS

L	T	P	C
3	0	0	3

This course introduces the student to familiar with radio frequency, power measurements, millimeter wave, spectrum analyzer, Signals and sources of microwave measurements. The first, third and fifth units cover the radio frequency, power, phase-noise, S-parameters, transmission measurements of microwave and millimeter wave. The second and fourth units cover signals and sources and spectrum analyzer.

Course Objectives

- To familiarize the radio frequency, power, phase-noise, S-parameters, transmission measurements used in microwaves and millimeter waves
- To explain the concepts of scalar analyses, vector measurement system and signal detection in signal generation.
- To introduce the importance of theory of phase-noise measurement, phase-lock detection and frequency measurement.
- To impart the knowledge about the spectrum **analyzer** and its resolution bandwidth, resolution shape factor.
- To expose basic concept of the Rieke diagram and Characteristics of microwave sources used in microwave power measurement.

Unit I **8L**

Introduction to Radio Frequency & Microwave Measurements, Introduction Radio Frequency Band, microwave and millimeter wave, swept spectrum, Error Models: S- parameters, transmission measurements, error in reflection measurements.

Learning Outcomes:
After completion of this unit the student will be able to

- measure the radio, microwave and millimeter wave frequencies(L2).
- understand the radio frequency band and swept spectrum(L1).
- determine the transmission and S-parameters(L4).
- predict the error in reflection measurements(L5).

Unit II **8L**

Signal generation: Signals and sources, YIG Tuned Oscillators, Synthesised sweepers, Vector measurement system, signal detection, scalar analyses: scalar analysis, components of scalar analysis, reflection bridges.

Learning Outcomes:
After completion of this unit the student will be able to

- describe the sources of signal generation and physical operation of tuned oscillators and synthesised sweepers (L1).
- discuss the signal detection and vector measurement system(L3).

- explain the use of reflection bridges in microwave measurements(L2).
- describe the concept of scalar analysis of components(L5).

Unit III **8L**

Frequency stability and measurement: Noise in signal sources, Short-term, Long-term noise, Theory of phase-noise measurement, Phase-lock detection, Frequency fluctuation and Allan variance, direct measurement of two-sided power spectral density, Frequency measurement

Learning Outcomes:
After completion of this unit the student will be able to
- describe the short-term and long-term noises in signal sources (L1).
- understand the theory of phase-noise measurement and phase-lock detection (L4).
- determine the two-sided power spectral density and frequency using direct measurement (L1).
- explain frequency fluctuation and all a variance (L3).

Unit IV **8L**

Spectrum analyzer: Frequency accuracy and long-term drift, Noise sidebands, Residual FM, Input sensitivity, Intermediation distortion, Resolution bandwidth, Resolution shape factor.

Learning Outcomes
After completion of this unit the student will be able to
- understand the working of spectrum analyzer (L2).
- discuss about frequency accuracy and long-term drift (L1).
- explain the noise sidebands, residual FM and input sensitivity (L3).
- describe the intermediation distortion, resolution bandwidth and resolution shape factor(L5).

Unit V **10L**

Power measurement: Characteristics of microwave sources, The Rieke diagram, Errors in the external circuit, Power-head elements, High-power measurements, Automatic measurements with power meters.

Learning Outcomes
After completion of this unit the student will be able to
- describe the Characteristics of microwave sources(L2).
- discuss the Rieke diagram and observe the errors in external circuit(L1).
- describe the different power head elements(L4).
- explain the automatic measurement of high power using power meters(L3).

Text Book (s)

1. G. H. Bryant, "Principles of Microwave Measurements"-,Peter Peregrinus Ltd.IEE,1993

References

D.Pozar," Microwave Engineering", 2nd Ed, John Wiley
T.S.Laverghetta-" Hand book on Microwave Testing",Artech House,1981

S.F.Adam-“ Microwave Theory & Application”- Prentice Hall, Inc
A.E. Bailey, Ed.” Microwave Measurements”- Peter Peregrinus Ltd, IEE,1985.

Course Outcomes:

Successful completion of the course, the student will be able to

- measure the radio, microwave, millimeter wave frequencies and determine the transmission and S-parameters (L1)
- understand the radio frequency band and swept spectrum(L3).
- describe the sources of signal generation and physical operation of tuned oscillators and synthesized sweepers (L5).
- explain the use of reflection bridges in microwave measurements(L4).
- understand the theory of phase-noise measurement and phase-lock detection(L2).
- describe the short-term and long-term noises in signal sources and determine the two-sided power spectral density and frequency using direct measurement(L3).
- understand the working of spectrum analyzer and discuss about frequency accuracy (L4).
- describe the intermediation distortion, resolution bandwidth and resolution shape factor(L3).
- describe the Characteristics of microwave sources and discuss the Rieke diagram for observing the errors in external circuit(L5).

19EEC751: FIBER OPTIC COMMUNICATIONS

L	T	P	C
3	0	0	3

This is an advanced course in communications implementing fiber optic cable for telecommunication industry. The basics of LED, LASER, photo diode, photo multipliers and its applications in Fiber optic communications are described. The construction of optic fiber cables are detailed. The suitable couplers and connecters are analyzed for Wave length division multiplexing for fiber optic communications. Analyzed the Losses in fiber optic communications and methods are described to minimize the errors to improve the performance of fiber optic communications to the telecom industry.

Course Objectives

- To Recognize and classify the structures of Optical fiber and types.
- To Discuss the channel impairments like losses and dispersion.
- To Analyze various coupling losses.
- To Classify the Optical sources and detectors and to discuss their principle.
- To Study of couplers and connectors
- Detection and correction of noise in FOC
- Design considerations of fiber optic communication systems.

MODULE –I **8L**

Optic Fiber Waveguides: Introduction, Ray theory, Step – Index Fiber, Graded – Index Fiber, Attenuation, Pulse Distortion and Information Rate in Optic Fibers, Construction of Optic Fibers, Optic Fibers, Optic Fiber Cables.

Learning Outcomes:

- recall basic laws of optical physics (L1).
- distinguish between the various modes of operation of Optical fibers (L2).
- identify the various causes for signal degradation (L4).
- estimate the various types of losses occurring in transmission of energy (L5).
- predict the pulse broadening happening due to the effect of dispersion of the signal (L6).

MODULE –II **8L**

Light Sources and Detectors: Light-Emitting Diodes, Light-Emitting – Diodes Operating Characteristics, Laser Principles, Laser Diodes, Laser-Diode Operating Characteristics, Distributed – Feedback Laser Diode, Optical Amplifiers, Fiber Laser, Principles of Photo detection, Photomultiplier, Semiconductor Photodiode, PIN Photodiode, Avalanche Photodiode.

Learning Outcomes:

- categorize the types of sources of light on basis of physical construction and principle of operation (L2).
- describe the conversion of light energy to electrical energy (L1).
- classify the optical detectors on basis of ability to efficiently detect and hence convert electrical energy into light energy (L4).
- describe the various phenomenon involved in the conversion of electrical energy into light energy (L5).

MODULE –III **9L**

Couplers and Connectors: Principles, Fiber end Preparation, Splices, Connectors, Source Coupling, Distribution Networks and Fiber Components, Distribution Networks, Directional Couplers, Star Couplers, Switches, Fiber Optical Isolator, Wavelength- Division Multiplexing.

Learning Outcomes:

- identify the necessity for using couplers and connectors in energy transmission (L1).
- able to know different types of couplers and their applications (L2).
- identify various practical problems faced while using couplers and connectors (L4).
- able to know how WDM accomplished (L3).

MODULE –IV **9L**

Modulation, Noise and Detection: Light-Emitting-Diode Modulation and Circuits, Laser-Diode Modulation and Circuits, Analog-Modulation Formats, Digital-Modulation Formats, Optic Heterodyne Receivers, Thermal and Shot Noise, Signal-to-Noise Ratio, Error Rates, Modal Noise, Amplifier Noise, Laser Noise, and Jitter, Additional Noise Contributors, receiver Circuit Design.

Learning Outcomes:

- study of modulation circuits (L1).
- study of modulation formats (L1).
- operation of optical receiver (L2).
- identify the various effects introducing noise in the system (L4).
- evaluate the performance of digital receiver by calculating the probability of error (L6).
- receiver circuit design (L3).

MODULE –V **8T**

System Design and Fiber Optical Applications: Analog System Design, Digital System Design, Applications of Fiber Optics.

Learning Outcomes:

- explain the use of analog and digital links (L2).

- design of analog and digital system (L4).
- describe the various criteria viz. power loss wavelength to be considered for point to point link in digital link system (L6).
- able to know the where we can use optical fibers (L3).

Course outcomes

- advantages and Various Applications of Fibre Optic Communications (L3).
- distinguish between the various modes of operation of Optical fibers (L2).
- identify the various causes for signal degradation due to losses, dispersion, polarization (L2).
- describe the optical detectors, couplers and connecters and their applications in Fiber optic communications (L4).
- the importance of the Wavelength Division Multiplexing (L4).
- design of analog and digital links (L6).
- discuss the various noises to consider in FOC receiver circuit design (L6).

Prescribed Text Book :

1.Joseph. C. Palais, "Fiber Optic Communications", Pearson Education,5th edition Asia, 2009.

Reference Text Books:

1. John Powers ,"Fiber Optic Systems" Tata McGraw-Hill Publications, 2nd edition 2010
2. John M.Senior, "Optical Fiber Communication: Principles and Practice", Pearson Education, 3rd edition, 2010
3. Gerd Keiser, "Optical Fiber Communication",Tata McGraw-Hill publications,4th edition,2008

Course outcomes

- advantages and Various Applications of Fibre Optic Communications (L3).
- distinguish between the various modes of operation of Optical fibers (L2).
- identify the various causes for signal degradation due to losses, dispersion, polarization (L2).
- describe the optical detectors, couplers and connecters and their applications in Fiber optic communications (L4).
- the importance of the Wavelength Division Multiplexing (L4).
- design of analog and digital links (L6).
- discuss the various noises to consider in FOC receiver circuit design (L6).

19EMC741: RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

This course introduces the student, to the fundamentals of research, research process, technical writing and intellectual property rights. Students will be able to use this knowledge to gain interest in their subject area and pursue their career in research.

Course Objectives:

- To familiarize the meaning, objectives and sources of research
- To acquaint the student with the importance and methods of literature review/research ethics
- To impart the knowledge of technical writing for preparing reports, presentations, research proposals, conference/journal publications
- To introduce the terminology and process of obtaining intellectual property rights
- To expose the intricacies in the process of obtaining patent rights

Unit I **5L**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the meaning of a research problem(L2).
- list the different sources of research problem(L1).
- enumerate the different criteria of good research and list the different errors in selecting research problem(L4).
- contrast the different approaches of research(L3).
- compare the different methods for data collection and analysis(L5).

Unit II **5L**

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Learning Outcomes:

After the completion of this unit, the student will be able to

- list and elaborate the different steps of the research process(L1).
- explain the importance of carrying out an effective literature review (L3).
- identify the research gaps from literature review(L4).
- describe the ethical principles to be following during research process and authorship(L2).

- define the terminology and list the methods to avoid being accused of plagiarism(L2).
- list the different types of research misconduct(L5).

Unit III **5L**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the attributes, reasons and guidelines for effective technical writing (L3).
- contrast between conference paper, technical presentation and journal paper (L2).
- choose a particular research contribution for patenting or journal publication (L4).
- define the terminology related to citation, citation index, h-index etc (L1).

Unit IV **5L**

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. **International Scenario**: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the codes and standards in building intellectual property rights(L3).
- list the subject, importance and requirements for of patentability(L5).
- explain the process of patenting and commercialization in academia(L1).
- enumerate the procedure for application preparation, filing and grant of Patents(L2).
- define the terminology related to citation, citation index, h-index etc(L4).

Unit V **8L**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR**: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the scope of patent rights (L1).
- describe the process for licensing and transfer of technology (L3).
- identify the sources of patent information and databases (L2).
- elaborate the administration of patent system (L5).
- describe the new developments in IPR in computer software, biological systems etc (L4).

Text Book(s):

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for Science and engineering students", Tata Mcgraw Hill India, 2013.
2. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 2/e, Prentice Hall of India, 2013.

References:

1. Halbert, "Resisting Intellectual Property", Taylor and Francis Limited, 2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publishers, 2008

Course Outcomes:

After successful completion of the course, the student will be able to

- define the meaning, sources, approaches for research problems (L2).
- explain the guidelines for carrying out effective literature review and identify research gaps (L1).
- describe effective guidelines for preparing technical reports, research publications, presentations and research proposals (L4).
- describe the codes, standards and process of obtaining intellectual property rights (L3).
- enumerate the new developments of IPR in engineering systems (L4).

19EEC721: MICROWAVE MEASUREMENTS LABORATORY

L	T	P	C
0	0	4	2

Course Objectives:

1. To Learn about the Microwave components of different frequency bands
2. To measure parameters like VSWR using Microwave bench setup.
3. To learn and analyze coupling measurements of H & E – Plane and Magic-Tee Junctions
4. To learn various constraints like impedance, attenuation frequency etc for a wave guide.
5. To learn about scattering parameters in detail.

List of Experiments

The following parameters are to be measured with X, S and Ku band microwave components.

1. Reflex Klystron Characteristics.
2. Gunn Diode Characteristics.
3. Directional Coupler Characteristics.
4. VSWR measurements.
5. Impedance, wavelength and frequency measurements.
6. Measurement of Scattering Parameters.
7. Measurement of attenuation Constant.
8. Coupling Measurement of H & E – Plane and magic-Tee Junctions
9. Measurement of dielectric constant.
10. Measurement of phase shift.
11. Circulators / Isolators

Course Outcomes:

Successful completion of the course, the student will be able to

1. Identify and analyze microwave components for different frequency bands
2. Measure and Calculate different parameters like frequency, attenuation, impedance, VSWR etc
3. Measure power at different ports of H & E – Plane and magic-Tee Junctions
4. Check the performance of circulator and isolator efficiently.

19EEC723: ANTENNA MEASUREMENTS LABORATORY

L	T	P	C
0	0	4	2

Course Objectives:

1. To Learn about the Microwave components of different frequency bands
2. To measure radiation pattern of different antennas
3. To verify reciprocity theorem
4. To learn and analyze coupling measurements of H & E – Plane and magic-Tee Junctions
5. To learn various constraints like impedance, attenuation, Polarization of different antennas

List of Experiments

1. Measurement of frequency and wave length.
2. Measurement of Radiation pattern and gain of horn antenna.
3. Measurement of Radiation pattern and gain of different dipole antennas.
4. Measurement of unknown load impedance
5. Determination of Polarization of antennas.
6. Study of microwave components
7. Measurement of attenuation characteristics
8. Measurement of parameters of directional coupler
9. Verification of Reciprocity Characteristics of antennas.
10. Measurement of coupling factor of E-plane tee and H-plane Tee junction

Course Outcomes

Successful completion of the course, the student will be able to

1. Measure radiation pattern of different antennas
2. Verify reciprocity theorem
3. Learn about the Microwave components of different frequency bands
4. Learn various constraints like impedance, attenuation, Polarization of different antennas
5. Learn and analyze coupling measurements of H & E – Plane and magic-Tee Junctions

19EAC741: ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

This course introduces the student, to the different aspects of research paper writing including planning, preparation, layout, literature review write-up etc. Specifically the perspective and style of writing in different sections of a research paper is highlighted. Students will exposed to English language skills relevant to research paper writing.

Course Objectives:

- To write clearly, concisely and carefully by keeping the structure of the paper in mind.
- To use standard phrases in English and further improve his command over it.
- To write with no redundancy, no ambiguity and increase the readability of the paper.
- To plan and organize his paper by following a logical buildup towards a proper conclusion.
- To decide what to include in various parts of the paper.
- To write a suitable title and an abstract in order to attract the attention of the reader.
- To identify the correct style and correct tense.
- To retain the scientific value of the paper by using minimum number of words.

Unit I **5L**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Learning Outcomes:

After the completion of this unit, the student will be able to

- to know the expectations of various journals and referees(L2).
- to know the typical structure of a paper(L1).
- learn to put words in a sentence in the correct order (L4).
- to write short and clear sentences from the very beginning of the paper(L5).
- to increase the readability of the paper by making it easy to read and 100% clear(L3).
- learn to be concise without losing any important content(L6).
- to avoid some typical grammar mistakes made in research papers(L1).

Unit II **5L**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Learning Outcomes:

After the completion of this unit, the student will be able to

- learn to make useful contribution worth recommending for publication (L1).
- learn good use of language to make readers notice the key findings (L3).
- learn to anticipate or predict possible objections to the claims made in the paper(L5).

- to understand what is plagiarism, and how to paraphrase other people's work (L2).
- learn to attract the right kind of readers with a suitable title(L4).
- learn to sell the abstract to potential readers by attracting their curiosity (L4).

Unit III **6L**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Learning Outcomes:

After the completion of this unit, the student will be able to

- have a deep knowledge about everything that has been previously written on the topic and decide what is important to know in Introduction(L2).
- learn to provide the right amount of literature regarding the sequence of events leading up to the current situation in the Literature review(L1).

Unit IV **6L**

Writing Skills: skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

Learning Outcomes:

After the completion of this unit, the student will be able to

- learn to describe the materials used in experiments and/or the methods used to carry out the research (L1).
- the key skill is in reporting the results simply and clearly (L2).
- learn to structure the Discussion and satisfy the typical requirements of the referees (L1).
- learn to provide a clear and high-impact take-home message in the conclusion (L4).

Unit V **6L**

Good Paper Writing: Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Learning Outcomes:

After the completion of this unit, the student will be able to

- learn various lists of frequently used phrases that have a general acceptance in all disciplines and use in specific sections of the paper (L1).
- learn various kinds of things one should look for when doing the final check (L2).

Text Book (s**):**

1. Goldbort R, Writing for Science, Yale University Press, 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM, Highman, 1998.

References:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:

By the end of the course the students will be able to:

- frame the structure of the paper precisely (L2).
- improve his command over English by using standard phrase (L3).
- avoid repetition and mistakes in the paper and increase its readability (L3).
- organize the paper logically towards a proper conclusion (L4).
- decide on the content to be included in various parts of the paper (L5).
- identify whether to use personal or impersonal style in the paper (L5).
- express the content in a clear and concise way (L6).
- attract the attention of the reader by providing a suitable title and an appropriate abstract (L6).

19EAC742: DISASTER MANAGEMENT

L	T	P	C
2	0	0	0

This course is intended to provide fundamental understanding of different aspects of Disaster Management. It will expose the students to the concept and functions of Disaster Management and to build competencies of Disaster Management professionals and development practitioners for effective supporting environment as put by the government in legislative manner. It would also provide basic knowledge, skills pertaining to Planning, Organizing and Decision-making process for Disaster Risk Reduction.

Course Objectives:

- To provide students an exposure to disasters, their significance, types & Comprehensive understanding on the concurrence of Disasters and its management.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures.
- Equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision-making and Problem solving methods for Disaster Management.
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Unit I **5L**

Introduction Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning, list the factors and mention the significance of disaster (L3).
- distinguish between hazard and disaster (L2).
- compare manmade and natural disaster (L4).
- list the types of disaster and describe their magnitude (L1).

Unit II **5L**

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the meaning, list the factors and mention the significance of disaster (L2).
- distinguish between hazard and disaster (L1).

- compare manmade and natural disaster (L3).
- list the types of disaster and describe their magnitude (L4).

Unit III **6L**

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the seismic zones and their characteristics (L1).
- identify the areas prone to floods and droughts (L3).
- distinguish between landslides and avalanches (L2).
- identify areas prone to cyclonic and costal hazards (L5).
- enumerate the post disaster diseases and epidemics (L3).

Unit IV **6L**

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, media reports: governmental and Community Preparedness.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the monitoring of phenomena triggering a disaster/hazard (L1).
- evaluate the risk with the use of remote sensing and meteorological data (L5).
- list the governmental and community measures for disaster preparedness (L2).

Unit V **6L**

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Learning Outcomes:

After the completion of this unit, the student will be able to

- define and list the elements of disaster risk (L2).
- enumerate the measures for risk reduction (L3).
- apply the techniques of risk assessment (L1).
- identify the means of people's participation in risk assessment (L5).

Text Book(s):

1. R. Nishith, Singh A.K., Disaster Management in India: Perspectives, issues and strategies, New Royal Book Company., 2008.

2. Sahni, Pardeep, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi., 2012
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep and Deep Publication, 2007.

Course Outcomes:

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

- identify management activities in pre, during and post phases of disasters (L2).
- plan disaster management activities and specify measure for risk reduction (L1).
- apply risk assessment techniques in real life disaster scenarios (L4).

19EAC743: SANSKRIT FOR TECHNICAL KNOWLEDGE

L	T	P	C
2	0	0	0

This course is intended to expose the student to the fundamentals of Sanskrit language and its technical utility in forming the core principles of many engineering branches. Students taking this course shall be able to relate the core principles of engineering branches to semantics of Sanskrit language

Course Objectives:

- to provide the knowledge of Sanskrit alphabets
- to expose the students to the basic grammar and sentence formation in past/present/future tenses
- to provide a classification of Sanskrit literature and its associated roots
- to demonstrate the relation of core engineering principles to the roots of Sanskrit literature

Unit I **9L**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

Learning Outcomes:

After the completion of this unit, the student will be able to

- define and list the elements of disaster risk(L1).
- enumerate the measures for risk reduction(L2).
- apply the techniques of risk assessment(L4).

Unit II **9L**

Order, Introduction of roots, Technical information about Sanskrit Literature.

Learning Outcomes

After the completion of this unit, the student will be able to

- classify the different branches of Sanskrit literature(L1).
- describe the order and roots of Sanskrit literature(L2).
- relate the applicability of Sanskrit literature to technical principles(L5).

Unit III **9L**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Learning Outcomes

After the completion of this unit, the student will be able to

- relate the technical concepts of engineering to principles of electrical technology(L1).
- relate the technical concepts of engineering to principles of mechanical engineering(L4).
- apply the use of Sanskrit knowledge to describe the mathematical principles(L3).

Text Book(s):

1. Dr.Vishwas, Abhyaspustakam, Samskrita Bharti Publication, New Delhi, 2005.
2. Vempati Kutumb Shastri, Teach Yourself Sanskrit, Prathama Deeksha, Rashtriya Sanskrit Sansthanam, New Delhi Publication, 2003.
3. Suresh Soni, India's Glorious Scientific Tradition, Ocean books, New Delhi, 2011.

Course Outcomes:

After successful completion of the course, the student will be able to

- get a working knowledge in illustrious Sanskrit, the scientific language in the world (L2).
- get a Learning of Sanskrit to improve brain functioning (L1).
- develop the logic in mathematics, science & other subjects with principles of Sanskrit(L4).
- explore the huge knowledge from ancient literature with the help of Sanskrit (L5).

19EAC744: VALUE EDUCATION

L	T	P	C
2	0	0	0

This course is intended to expose the student to the need for human values and methods to cultivate them for leading an ethical life with good moral conduct. Students taking this course will be able to experience a change in personal and professional behavior with these ethical principles guiding him throughout life

Course Objectives:

- To expose the student to need for values, ethics, self-development and standards
- To make the student understand the meaning of different values including duty, devotion, self-reliance etc.
- To imbibe the different behavioral competencies in students for leading an ethical and happy life
- To expose the student to different characteristic attributes and competencies for leading a successful, ethical and happy profession life.

Unit I **7L**

Values and self-development –social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the social values and individual attitudes for self-development (L2).
- describe the Indian vision of humanism (L1).
- distinguish between moral and non-moral acts (L3).
- list the standards and value principles for moral conduct (L5).

Unit II **7L**

Importance of cultivation of values. Sense of duty. Devotion, self-reliance. Confidence, concentration. Truthfulness, cleanliness. Honesty, humanity. Power of faith, national unity. Patriotism, love for nature, discipline.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the importance of cultivating values (L1).
- list the different traits of self-developed individual (L3).
- explain the need for loving nature/country/humanity (L2).

Unit III **7L**

Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering,

love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the benefits of positivie thinking, integrity and discipline (L2).
- list the different methods for avoiding fault finding, anger (L4).
- explain the methods to overcome suffering, religious intolerance, self-destructive habits (L3).

Unit IV **7L**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the science of reincarnation (L2).
- explain the relation between self-management and good health (L1).
- elaborate the role of different religions in reaching the common goal (L4).
- list the different techniques for mind-control to improve personality and studies (L3).

Text Book(s):

1. Chakroborty S.K., "Values and ethics for organizations: Theory and Practice", Oxford University Press, 1998.

Course Outcomes:

After successful completion of the course, the student will be able to

- appreciate the need for human values and methods for self development (L2).
- elaborate the different traits and benefits of a self-developed individual (L1).
- list the different attributes of self-developed individual (L4).
- elaborate the role and scope of books/faith/health/religions in character building and competence development (L3).

19EAC745: CONSTITUTION OF INDIA

L	T	P	C
2	0	0	0

This course is intended to expose the student to the philosophy of Indian constitution. Students will be able to understand their fundamental rights/duties and governance structure. Students also appreciate the role of election commission in establishing a democratic society.

Course Objectives:

- To familiarize the student about the need for a constitution
- To make the student understand the role of constitution in a democratic society
- To acquaint the student with key constitutional features and fundamental rights of a citizen
- To impart the organs of governance and local administration hierarchy and their responsibilities
- To familiarize the student with the role, responsibilities and administration hierarchy of election commission

Unit I

5L

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the outline of drafting committee and their roles in the making of Indian constitution (L1)
- describe the need and role of a constitution in a democratic society (L1)
- elaborate the salient features of Indian constitution (L2)

Unit II

5L

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the fundamental rights of a citizen (L2)
- explain the intricacies in the different rights (L3)
- elaborate the fundamental duties of a citizen (L3)
- describe the principles of state policy (L4)

Unit III **6L**

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Learning Outcomes:

After the completion of this unit, the student will be able to

- present the hierarchy of governance (L3)
- list the role/responsibilities/powers of different organs of governance (L4)
- elaborate the guidelines for appointment/transfer of judges (L5)

Unit IV **6L**

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the administrative organizational hierarchy of municipalities and panchayats(L4)
- appreciate the role/responsibilities/powers of mayor, CEO, elected officials (L5)
- appreciate the importance of grass root democracy (l5)

Unit V **6L**

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

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the administrative hierarchy of election commission (L5)
- elaborate the roles/responsibilities/powers of election commissioners at different levels of hierarchy (L5)
- outline the welfare activities of SC/ST/OBC/Women by different bodies (L4 & L5)

Text Book(s):

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1/e, 2015.
3. M. P. Jain, Indian Constitution Law, 7/e, Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

After successful completion of the course, the student will be able to

- describe the philosophy and salient features of Indian constitution (L1)
- list the constitutional rights and duties of a citizen (L3)
- elaborate the central and local administrative hierarchy and their roles (L2)
- describe the roles/responsibilities/powers of different governing and administrative bodies (L4)
- explain the structure/functioning and power of election commission (L5)

19EAC746: PEDAGOGY STUDIES

L	T	P	C
2	0	0	0

This course is aimed to familiarizing the student with pedagogical principles, practices and methodologies. This course is intended for students interested in pursuing a career in teaching and research.

Course Objectives:

- To familiarize the student about the need for pedagogy studies, background and conceptual framework
- To expose the student to pedagogical practices in formal/informal classrooms
- To acquaint the student with type of curriculum and guidance materials for effective pedagogy
- To familiarize the student with classroom practices and curriculum assessment procedures
- To make the student understand the effect of undertaking research on teaching quality

Unit I **5L**

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

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the aim and rationale behind teacher education (L2).
- classify the different theories of learning (L1).
- elaborate the need and role of curriculum, teacher education (L3).

Unit II **5L**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the different pedagogical practices used by teachers in formal and informal classrooms(L2).
- explain the pedagogical practices employed in developing countries (L1).
- enumerate the duties of faculty in terms of teaching, research, consultancy, administration (L4).

Unit III **6L**

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

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the measures for effective pedagogy (L1).
- identify the different documentation required to formalize curriculum implementation and quality assessment (L3).
- describe the teachers attitudes and beliefs in pedagogic strategies (L4).

Unit IV **6L**

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the organizational hierarchy in a school administration system (L3).
- list the different barriers to learning (L1).
- enumerate the methods to overcome limited resources and handle large class sizes (L4).
- describe the follow-up support and peer-support in classroom practices (L2).

Unit V **6L**

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

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the need for and role of research in teaching profession (L1).
- list the different research activities to be taken up by teachers (L2).
- describe the impact of research on teaching quality and learning process (L4).

Text Book(s):

1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261, 2001
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, 2004.
3. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID., 2003.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282., 2013.
5. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell., 2001.
6. Chavan M, Read India: A mass scale, rapid, 'Learning to Read' campaign., 2003.

Course Outcomes:

After successful completion of the course, the student will be able to

- describe the theories of learning and conceptual framework of pedagogy (L2).
- explain the pedagogical practices used by teachers in formal and informal classrooms (L1).
- visualize the administrative hierarchy of schools and colleges and define the role (L4).
- appreciate the need for research and define the future direction of teaching career (L3).
- describe the impact of curriculum and assessment on the teaching learning process of a student (L5).

19EAC747: STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with basic principles of yoga and different physical/mental practices for managing mind and body. This course helps the student in managing stress during education, home and workplace. Further, principles learnt in this course help in building overall personality for a stress-free, happy and independent life.

Course Objectives:

- To familiarize the student about eight parts of yoga and their significance
- To expose the student to the importance and meaning of Yam and Niyam
- To make the student understand the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
- To introduce the different yogic poses with a knowledge of their benefits for mind and body
- To familiarize the effect of different types of breathing techniques in concept and in activity

Unit I **9L**

Definitions of Eight parts of yoga (Ashtanga).

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the eight parts of yoga(L2).
- describe the effects of different parts of yoga on mind and body(L1).
- elaborate the importance of yoga in stress management and personality development(L3).

Unit II **9L**

Yam and Niyam.
Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Learning Outcomes:

After the completion of this unit, the student will be able to

- elaborate the importance of Yam and Niyam(L2).
- describe the meaning and significance of Ahinsa, satya, astheya etc(L1).
- explain the need for shaucha, santosh, tapa, swadhyay in leading a healthy and fruitful life(L3).

Unit III **9L**

Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its Effects-Types of pranayam.

Learning Outcomes:

After the completion of this unit, the student will be able to

- demonstrate the different physical asanas and explain their physical and phychological effects(L1).
- demonstrate the different breathing techniques and describe their physical and mental effects (L3).
- distinguish between different types of pranayamam(L4).

Text Books

1. Janardan, Yogic Asanas for Group Tarining-Part-I, Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature", Advaita Ashrama, Kolkata

Course Outcomes :

After successful completion of the course, the student will be able to

- describe the eight parts of yoga and their significance(L1).
- explain the the importance and meaning of Yam and Niyam(L3).
- define the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc(L2).
- demonstrate the different yogic poses and explain their benefits for mind and body(L4).
- demonstrate the different types of breathing techniques and explain their physical and mental benefits(L5).

19EAC748: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with life enlightenment skills for personality development. This course helps the student in building his holistic personality through human values, ethics and spiritual attributes.

Course Objectives:

- To familiarize the student to good personality traits through moral stories
- To make the student understand the goal of human life and importance of good personality in reaching the goal
- To expose the student to the study of Shrimad-Bhagwad-Geeta for developing his/her personality and achieve the highest goal in life
- To familiarize the student to leadership skills for driving nation and mankind to peace and prosperity
- To expose the role of Neetishatakam for developing versatile personality of students.

Unit I **9L**

Neetisatakam-Holistic development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)
Verses- 52,53,59 (dont's)
Verses- 71,73,75,78 (do's).

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the moral stories illustrating the traits of good personality (L1)
- define the meaning and importance of wisdom, pride, heroism, virtue etc (L2)
- identify do and donts in life from the foundations of human morals/ethics (L2)

Unit II **9L**

Approach to day to day work and duties.
Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48,
Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
Chapter 18-Verses 45, 46, 48.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the characteristics and principles of bhakti yogam, jnana yogam and karma yogam (L3)
- identify the use of different yogic characteristics in different activities of daily life/duties (L4)
- apply the use of yogic principles for leading a stress-free, happy and fruitful life with good developed personality (L4)

Unit III **9L**

Statements of basic knowledge.
Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model. Shrimad BhagwadGeeta:
Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Learning Outcomes:

After the completion of this unit, the student will be able to

1. list the characteristics of role model proposed by verses of bhagavad gita (L3)
2. explain the methods for obtaining life enlightenment through the practice of four yoga appropriately (L4)
3. describe the characteristics of karma yogi/jnana yogi for developing leadership personality (L5)

Text Book(s):

1. Swami Swarupananda, "Srimad Bhagavad Gita", Advaita Ashram (Publication Department), Kolkata
2. P. Gopinath, Bhartrihari's Three Satakam (Niti-Sringar-vairagya), Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes:

After successful completion of the course, the student will be able to

- List the different parables of neethisathakam and identify their morals (L1)
- enumerate the different traits of human personality for life enlightenment (L2)
- describe the leadership attributes for driving nation and mankind to peace and prosperity (L3)
- explain the applicability of different types of yoga to day-to-day work and duties resulting in responsible personality (L4)

19EAC750: DEVELOPING SOFT SKILLS AND PERSONALITY

L	T	P	C
2	0	0	0

Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The course aims to cause a basic awareness within the students about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality.

Course Objectives

- to familiarize the student to the criteria for self assessment and significance of self-discipline
- to expose the student to attitudes, mindsets, values and beliefs
- to acquaint the student to plan career and goals through constructive thinking
- to enable the student to overcome barriers for active listening and persuasive speaking
- to familiarize the skill of conducting meetings, writing minutes and involving in active group discussions

Unit I **(8L)**

Self-Assessment; Identifying Strength & Limitations; Habits, Will-Power and Drives; Developing Self-Esteem and Building Self-Confidence, Significance of Self-Discipline

Learning Outcomes

After the completion of this unit, the student will be able to

- identify strengths & limitations through self-assessment(L3)
- list the attributes of personalities will good will-power and self-drives(L1)
- describe the reasons for building self-esteem and self-confidence(L2)
- explain the significance of self discipline(L2)

Unit II **(8L)**

Understanding Perceptions, Attitudes, and Personality Types: Mind-Set: Growth and Fixed; Values and Beliefs

Learning Outcomes

After the completion of this unit, the student will be able to

- define the characteristics of different perceptions, attitudes and personality types(L1)
- distinguish between fixed and growing mindsets(L3)
- define the importance and meaning of values and beliefs(L2)

Unit III **(8L)**

Motivation and Achieving Excellence; Self-Actualisation Need; Goal Setting, Life and Career Planning; Constructive Thinking

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the need for having high motivation and achieving excellence(L2)
- define the need for self-actualization(L1)
- plan the life and career goals based on self assessment(L4)
- explain the attributes of constructive thinking(L2)

Unit IV **(8L)**

Communicating Clearly: Understanding and Overcoming barriers; Active Listening; Persuasive Speaking and Presentation Skills.

Learning Outcomes

After the completion of this unit, the student will be able to

- self-assess the barriers for communicating clearly (L4)
- list the attributes of active listening(L1)
- describe the minimal aspects of effective presentation(L2)
- organize ideas resulting a persuasive talk(L3)

Unit V **(8L)**

Conducting Meetings, Writing Minutes, Sending Memos and Notices; Netiquette: Effective E-mail Communication; Telephone Etiquette; Body Language in Group Discussion and Interview.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the format and structure of writing meeting minutes(L2)
- identify the essential components of memos and notices(L3)
- explain the principles of effective email communication(L2)
- list the basic etiquette of telephone conversation(L1)
- describe the effective body traits during group discussion and interviews(L2)

Text Books

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman& Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

Course Outcomes

After successful completion of the course, the student will be able to

- carry out self assessment and describe the significance of self-discipline(L4)
- define, classify and compare attitudes, mindsets, values and beliefs(L3)
- plan career and goals through constructive thinking and personal assessment(L4)
- overcome barriers for active listening and persuasive speaking (L5)
- conduct meetings, write minutes and involve in active group discussions(L3)

19EEC702: MICROWAVE DEVICES AND INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

This course is designed to get the knowledge about Microwave Devices and its frequency spectrum. Because Microwave is one of the most important part of communication system. This course is useful for the students to know about microwave transmission lines (wave guides), matching techniques and its application. The importance of microwaves started way back in World War II period and later expanded its ways out to domestic (microwave oven), military, commercial, satellite and RADAR etc. Students also can get the knowledge about its harmful effect and it's protecting technique.

Course Objectives:

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency.
- Understand Microwave sources and amplifiers.
- To understand the theoretical principles underlying microwave devices and networks.
- To study Microwave semiconductor devices & applications.
- To become familiar with the concepts of Microwave Integrated Circuits its fabrication.
- To study about Microwave Solid-State Microwave Devices and Microwave Tubes.

Unit I **8L**

Microwave transistors and FETs: Introduction, microwave bipolar transistors, hetero junction bipolar transistors, junction field effect transistors, metal semiconductor field effect transistors, high electron mobility transistors, MOSFETs.

Learning outcomes:

After completion of this unit the student will be able to

- understand microwave semiconductor materials(L2).
- understand semiconductor materials behavior under microwave signals(L1).
- understand microwave semiconductor devices(L5).
- understand microwave transistor operations(L3).
- apply BJTs and FETs in microwave circuits(L4).

Unit II **8L**

Microwave O-type tubes: High frequency limitations of conventional tubes, reentrant cavities, klystrons, velocity modulation process, bunching process, output power and beam loading, reflex klystron, velocity modulation, power output and efficiency, electronic admittance, mode patterns,

slow wave structures, traveling wave tube, amplification process, wave modes, gain considerations.

Learning outcomes:

After completion of this unit the student will be able to

- understand Reentrant cavities(L1).
- understand the velocity modulation and bunching process in Klystron, Reflex klystron(L2).
- understand slow wave structures and amplification process of TWT(L4).
- understand Microwave sources and amplifiers(L3).

Unit III **8L**

Microwave M-type tubes: Introduction, magnetron - types, principle of operation of cylindrical magnetron, hartee resonance condition, pi-mode separation, forward – wave crossed field amplifier, backward – wave crossed field amplifier.

Learning outcomes:

After completion of this unit the student will be able to

- understand principle of magnetron and hartee resonance condition(L1).
- understand the difference between forward, backward wave cross field amplifiers(L3).
- analyze and compare the characteristics of microwave tubes(L2).

Unit IV **8L**

Microwave solid state Devices: Classification, GUNN Effect diodes, Ridley – Watkins – Hilsum (RWH) theory, modes of operation, LSA diode, microwave generation and amplification, applications, read diode, IMPATT diodes, TRAPATT diodes, applications of IMPATT and TRAPATT diodes, PIN diode, varactor diode, parametric amplifiers, tunnel diode.

Learning outcomes:

After completion of this unit the student will be able to

- understand and apply Varactor and PIN diodes(L2).
- understand IMPATT and TRAPATT devices and their applications(L1).
- understand and apply GUNN diode, LSA diode, varactor diode, tunnel diode and parametric amplifier(L4).
- apply GUNN devices in frequency multipliers and oscillators(L3).
- apply PIN diodes in microwave switches(L1).

Unit V **8L**

Strip lines and microwave integrated circuits: Microstrip lines, parallel strip lines, coplanar strip lines, shielded strip lines, materials, monolithic microwave integrated circuit growth, MOSFET fabrication, thin film formation, hybrid IC fabrication.

Learning outcomes:

After completion of this unit the student will be able to

- understand Microwave Integrated circuits(L1).
- understand parallel strip lines, coplanar strip lines, shielded strip lines and its applications(L3).
- understand the fabrications of microstrip lines and hybrid IC(L1).
- understand MOSFET applications in microwave amplifiers(L2).

Text Book:

1. Samuel. Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2014.

References

1. Annapurna Das and Sisir K. Das ,Microwave Engineering, Tata Mcgraw Hill, 2013.
2. Jacob Millman, Microelectronics, Tata Mc Graw Hill, 2010.
3. Sushrut Das, Microwave Engineering, Oxford University Press, 2015.

COURSE OUTCOMES:

- understand the significance of microwaves and microwave transmission (L1).
- understand the various microwave transistors and FET devices and their performance (L2).
- analyze and classify the microwave tubes (Linear beam tubes and Crossed field tubes) characteristics (L3).
- Be able to list and explain the various microwave solid state devices & applications (L5).
- design of microwave striplines and microwave transmission lines for a given set of parameters (L4).
- understand the various microwave semiconductor devices as oscillators for their Performance (L2).

19EEC742: PHASED ARRAY ANTENNAS

L	T	P	C
3	0	0	3

This course introduces the student, to analysis the phased array antennas based physical characteristics and mathematical equation wherever necessary. In first three Units the linear array antennas, the linear broadside array antenna, the linear endfire array antenna and the linear phased array antenna will be discussed. Unit 4 then extends the acquired knowledge of linear array and phased array antennas to planar array and phased array antennas and in unit 5 some special array antenna configurations will be discussed. These configurations are conformal and volume array antennas, sequentially rotated and fed arrays for the creation of circular polarisation and reactively loaded array antennas.

Course Objectives:

- To develop quantitative understanding of the linear broadside array antenna by specifying the radiation patterns and their parameters.
- To understand Hansen-woodyard endfire array antenna and yagi-uda array antenna and also explain mutual coupling.
- To expose phase shifting by changing frequency, length, permittivity, permeability of the linear phased array antenna.
- To impart knowledge about the characteristics of the planar array and phased array antenna.
- To introduce the importance of some special array antenna configurations.

Unit I **8L**

The Linear Broadside Array Antenna: Introduction, a linear array of non-isotropic point source radiators, plane waves, received signal, array factor, side lobes and grating lobes, first side lobe level, amplitude taper.

Learning outcomes:

After completion of this unit student will be able to

- define the linear broadside array antenna (L1).
- understand application of plane waves to the linear antennas (L3).
- draw the block diagram of linear array antenna with equal path length summing network (L2).
- calculate array factor for k isotropic linear array antenna radiation pattern (L4).
- understand the significance of side lobes and grating lobes of a radiation pattern (L5).

Unit II **8L**

The Linear Endfire Array Antenna: Introduction**,** phase differences, Hansen- woodyardendfire array antenna,mutual coupling, yagi-uda array antenna: Mutual impedance, radiation, antenna design considerations, problems

Learning outcomes:

After completion of this unit student will be able to

- construct and compare the ordinary endfire array and Hansen-woodyard endfire array(L1).
- understand the mutual coupling between linear isotropic antennas(L3).
- derive mutual impedance of yagi-uda antenna(L2).
- explain radiation mechanism in the yagi-uda antenna(L4).
- expose the design considerations of the linear array antenna(L5).

Unit III **8L**

The Linear Phased Array Antenna: Linear phase taper, beam broadening, grating lobes and visible space, means of phase shifting: Phase shifting by changing frequency, Phase shifting by changing length, Phase shifting by changing permittivity, Phase shifting by changing permeability.

Learning outcomes:

After completion of this unit student will be able to

- adjust the phase taper to scan the beam between the extreme pointing angels (L3).
- understand the concept of beam broadening with increasing scan angle clearer (L1).
- analyze phase shifting by changing frequency, length, permittivity and permeability (L2).

Unit IV **8L**

The Planar Array and Phased Array Antenna: Introduction, geometry, planar array antenna: Radiation, side lobe level, grating lobes, planar phased array antenna: Radiation, grating lobes.

Learning outcomes:

After completion of this unit student will be able to

- understand the geometry and feeding arrangements of the planar array antenna (L2).
- draw the radiation patterns and calculate array factor for different types of planar array antenna (L1).
- draw and explain the radiation patterns of planar phased array antenna (L3).

Unit UNIT -V **8L**

Special Array antenna configurations: Conformal array and Phased array antennas: Circular sector array and phased array antennas, volume array and phased array antennas, sequential rotation and phasing, reactive loading.

Learning outcomes:

After completion of this unit student will be able to

- expose different type of special array antenna configurations(L1).
- analyze the radiation pattern of circular sector array and phased array antennas(L3).
- draw the schematic of volume array and phased array antenna(L5).
- understand the importance of sequential rotation and phasing of array antenna(L2).

Text Books:

1. Hubregt J Visser, Array and Phased array antenna basics, John Wiley and Sons Ltd., 2012
2. Balanis, C.A., Antenna Theory and Design, 3/e., John Wiley and Sons. 2013

References

1. Robert J. Mailloux, Phased Array Antenna Hand Book, Artech House, Boston, London, 1994

Course outcomes:

Successful completion of the course, the student will be able to

- analyze the radiation patterns of a linear array of non-isotropic point source radiators(L2).
- understand the effect of mutual coupling and mutual impedances(L1).
- explain the Linear phase taper, beam broadening, grating lobes and visible space, means of phase shifting(L3).
- analyze the radiation patterns of the planar array and phased array antenna(L4).
- understand the importance of conformal array and phased array antennas(L3).

19EEC744: COMPUTATIONAL TECHNIQUES IN ELECTROMAGNETICS

L	T	P	C
3	0	0	3

Field Theory is a fundamental theory. This course is designed for understanding Electro-magnetic fields, it is designed to provide knowledge related to time varying fields and their solutions. Computational techniques are used as design tools for many electromagnetic problems. Computational Electromagnetic is basically an interdisciplinary field which involves the solution of Maxwell's equations analytically using various methods of CEM and also determining the optimal method for a given problem. The Finite difference method, which is more or less straight forward discretization of Maxwell's equation in differential form using field concept on a grade of unknown points. Finite Element Method is mainly used for time-harmonic problems, the Method of Moments discretizes Maxwell's equations in integral form.

Course Objectives:

- To understand the Fundamental concepts of Electro-Magnetic Theory.
- To impart the knowledge of Separation of variables in different co-ordinate systems.
- To appreciate the Finite difference methods and Variation methods.
- To develop the skill to analyze Electro-Magnetic absorption and radiation problems.

Unit I **8L**

Fundamental Concepts:
Introduction, review of electromagnetic theory, electrostatic fields, Magneto static fields, time-varying field s, boundary conditions, wave equations, time-varying potentials, time-harmonic fields, classification of em problems, classification of solution regions, classification of differential equations, classification of boundary conditions, some important theorems, superposition principle, uniqueness theorem

Learning Outcomes:

After completion of this unit student will be able to

- understand the concept of Electro static and Magneto Static fields (L1).
- know about time-varying fields and their solutions (L2).
- determine classification of boundary conditions (L3).
- describe time-varying potentials and time-harmonic fields (L4).
- understand classification of EM problems and solutions (L5).
- illustrate about Uniqueness theorem and superposition principle (L6).

Unit II **8L**

Analytical Methods:
Introduction, separation of variables, separation of variables in rectangular coordinates, separation of variables in cylindrical coordinates, separation of variables in spherical coordinates, some useful orthogonal functions, series expansion

Learning Outcomes:

After completion of this unit student will be able to

- understand the concept of separation of variables in rectangular co-ordinate system (L1)
- know about separation of variables in cylindrical co-ordinate system (L2)
- understand the concept of separation of variables in spherical co-ordinate system (L4)
- determine series expansion (L5)
- describe orthogonal functions (L6)

Unit III **8L**

Finite Difference Methods:

Introduction, finite difference schemes, finite differencing of parabolic PDES, finite differencing of hyperbolic PDES, finite differencing of elliptic PDES, accuracy and stability of FD solutions, practical applications I — guided structures, practical applications II — wave scattering (FDTD), absorbing boundary conditions for FDTD, finite differencing for nonrectangular systems, numerical integration.

Learning Outcomes:

After completion of this unit student will be able to

- understand the finite difference scheme of parabolic PDES (L1)
- describe the finite difference scheme of parabolic PDES, hyperbolic PDES and elliptic PDES (L2)
- determine accuracy and stability of FD solutions (L3)
- know finite differencing for nonrectangular systems (L4)
- characterize absorbing boundary conditions of FDTD (L5)
- illustrate Numerical integration (L6)

Unit IV **8L**

Variational Methods:

Introduction, operators in linear spaces, calculus of variations, construction of, functionals from PDES, rayleigh-ritz method, weighted residual method, eigen value problems, practical applications

Learning Outcomes:

After completion of this unit student will be able to

- understand operators in linear spaces (L1)
- determine functionals from PDES (L2)
- know about Rayleigh-ritz and weighted residual methods (L3)
- solve Eigen value problem (L4)

Unit V **8L**

Moment Methods:

Introduction, integral equations, green's functions, applications I — quasistatic problems, applications II — scattering problems, applications III — radiation problems, applications IV — EM Absorption in the Human Body.

Learning Outcomes:

After completion of this unit student will be able to

- understand integral equations and green's functions (L1)
- know about quasistatic problems, scattering problems and radiation problems (L2)
- describe about EM absorption in Human body (L3)

Text Book:

1. Sadiku, M.N.O., Numerical Techniques in Electromagnetics, 2/e., CRC Press. 2009.

Reference Books:

1. Collin, R.E., Field Theory of Guided Waves, 2/e., Wiley-IEEE Press. 1995
2. Peterson, A.F, Ray, S.L. and Mittra, R., Computational Methods for Electromagnetics, Wiley-IEEE Press, 1998
3. Harrington, R.F., Field Computation by Moment Methods, Wiley- IEEE Press, 1993.

Course Outcomes:

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

1. describe Electromagnetic fields and also know about their solutions (L2).
2. explain the concept of different Analytical methods (L1).
3. explain the different Finite difference methods (L3).
4. understand how to solve Eigen value problems (L5).
5. explain about Integral equations and Green's functions (L2).
6. describe about EM absorption in the Human body (L4).
7. know the Quasistatic, Scattering and radiation problems (L1).

9EEC746: OPTICAL NETWORKS

L	T	P	C
3	0	0	3

To analyze and understanding of various issues in designing an optical network. Topics include SONET/SDH, wavelength division multiplexing, framing techniques, traffic grooming, multiple access protocols, virtual topology design, routing and wavelength assignment, protection and restoration, and optical access networks. The course will give the student in-depth understanding of the functionality of optical networks and how they may be implemented. How an optical network can work together with an IP-based network infrastructure for ensuring both high reliability and performance in access, metro and transport networks, is paid special attention.

Course Objectives:

1. To understand the need for optical networks, optical layers and losses.
2. To distinguish Various components of optical networks
3. To analyze the Multiplexing techniques and fiber characteristics
4. To impact the Optical amplifiers and cross connectors
5. To identify the Network management and access networks
6. To develop Internetworking and its layers

Unit I **8L**

Introduction to Optical Networks: Optical Networks, optical layer, optical packet switching, transmission basics, network evaluation. Propagation of signals in optical fiber: loss and bandwidth windows, intermodal dispersion, optical fiber as a waveguide, chromatic dispersion, nonlinear effects, solitons, other fiber technologies.

Learning Outcomes:

After completion of this unit student will be able to

- get a basic understanding of physical properties of optical networks (L1).
- get a profound understanding of protocols applied in optical networks (L2).
- distinguish between the various modes of operation of Optical fibers (L3).
- identify the various causes for signal degradation (L4).
- estimate the various types of losses occurring in transmission of energy (L5).
- predict the pulse broadening happening due to the effect of dispersion of the signal (L6).

Unit –II **8L**

Components: Couplers: Principle of Operation, isolators and circulators: Principle of Operation, multiplexers and filters, optical amplifiers, transmitters, detectors: Photo detectors, front end amplifiers, switches and wavelength converters.

Learning Outcomes:

After completion of this unit student will be able to

- identify the necessity for using couplers and connectors in energy transmission (L1).
- get a basic understanding of optical components (L2).
- know different types of couplers and their applications (L3).
- identify various practical problems faced while using couplers and connectors (L4).

Unit III **10 L**

Networks: SONET/SDH: Multiplexing, VCAT and LCAS, SONET/SDH Layers, SONET Frame Structure, SONET/SDH physical layer, elements of SONET/SDH infrastructure. WDM Network Elements: Optical Line Terminals, optical line amplifiers, optical add/drop multiplexers, optical cross connects

Learning Outcomes:

After completion of this unit student will be able to

- identify the various multiplexing the techniques (L1).
- different types SONET/SDH Layers (L2).
- identify various elements of SONET (L4).
- know how WDM accomplished (L3).
- recall basic optical cross connect (L4).
- recall basic of multiplexers add/drop (L5).

Unit IV **10 L**

Network survivability: Basic Concepts, protection in SONET/SDH, protection in client layers, optical layer protection, different schemes, internetworking between layers.

Learning Outcomes:

After completion of this unit student will be able to

- know different types of protection in SONET/SDH (L1).
- know about client and protection layer (L2).
- know internetworking (L3).
- know about internetworking layers (L4).

Unit V **10 L**

WDM network design: Cost Trade-Offs, LTD and RWA problems, dimensioning wavelength – routing networks. Access networks: network architecture overview, enhanced HFC, FTTC.

Learning Outcomes:

After completion of this unit student will be able to

- explain the use of cost tradeoffs (L1).
- design of LTD AND RWA problems (L2).
- know the dimensioning wavelength routing algorithm (L1).
- know the overview of access network (L3).

Text Book(s)

1. R Ramaswami, K Sivarajan, Optical Networks: A Practical Perspective 3/e, Morgan Kaufmann Publications, 2009.

References

1. Biswanath Mukherjee, Optical Communication Networks, New York, McGraw-Hill, 1997
2. Mayer, Martin, Optical Switching Networks, Cambridge University press, 2008.

Course outcomes:

- describe the various layers involved in network & Recall basic laws of optical physics. (L1)
- identify the necessity for using couplers and connectors in energy transmission. (L2)
- identify the various multiplexing the techniques (L3)
- recall basic of multiplexers add/drop (L4)
- able to know different types of protection in SONET/SDH (L4)
- explain the use of cost tradeoffs & Able to know the overview of access network (L5).

19EEC748: RF AND MICROWAVE MEMS

L	T	P	C
3	0	0	3

This course introduces the student, to the fundamental principles of Radio frequency, MEMS and its applications. The first three units cover the basics of microwaves and its transmission line waveguides with MEMS. The last two units covers High frequency design, MEMS technologies and components for RF and microwave applications.

Course Objectives:

- To familiarize the basic concepts of Microwave and RF MEMS.
- To explain the concepts of Transmission lines and its Networks.
- To introduce the importance of Networks and designing of High frequency.
- To impart the knowledge about the MEMS materials and fabrication techniques.
- To expose basic concepts of Integration and packaging for RF MEMS its applications

Unit I **8L**

Introduction: Introduction to microwave systems, wireless systems, personal communication systems, microwave propagation, High frequency effects in circuits and systems. Lumped-element circuit model for a transmission line, introduction to MEMs.

Learning Outcomes:

After completion of this unit the student will be able to

- explain the importance of microwave system (L2)
- study the operation and design of wireless system (L3).
- elaborate the importance of commercial wireless satellite systems (L1).
- construct the block diagram of basic radio system (L3).
- predict the importance of various standards for cellular telephone system (L2).

Unit II **8L**

Transmission lines and waveguides**:** Review of Transmission line Theory, terminated transmission lines, smith chart, impedance matching, lossy transmission lines, stripline, Micro strip and Coplanar waveguide implementations, general solutions for TEM, TE, and TM waves**,** microwave network analysis, ABCD parameters, S parameters.

Learning Outcomes:

After completion of this unit the student will be able to

- differentiate the standard circuit analysis and transmission line theory (L1).
- represent the graphical chart for transmission line problems and its operations. (L2).
- explain the importance of Impedance matching (L2).
- design analog IC for low frequency circuits (L3).
- influence the various types of Microwave network analysis (L1).

Unit III **8L**

Net works: Behavior of passive IC components and networks, series and parallel RLC circuits, resonant structures using distributed transmission lines, components and interconnects at high frequencies, impedance and admittance matrices, reciprocal networks, lossless networks.

Learning Outcomes:

After completion of this unit the student will be able to

- explain the behavior of passive IC components and networks (L2).
- analyze series and parallel RLC circuits (L3).
- describe the resonant structures using distributed transmission lines ((L2).
- illustrate impedance and admittance matrices (L3).
- describe reciprocal and lossless networks (L2).

Unit IV **8L**

High frequency system design: Basics of high frequency amplifier design, device technologies, biasing techniques, simultaneous tuning of 2 port circuits, noise and distortion, Feedback systems, phase locked loops, LNA design, designs based on impedance match noise performance, linearity, noise and large signal performance, Power amplifier design, Various classes of power amplifiers, Oscillators, linear oscillators, tuned oscillators, negative resistance oscillators Systems aspects in wireless trans-receiver design.

Learning Outcomes:

After completion of this unit the student will be able to

- explain the basics of high frequency amplifier with respect to design aspects (L2)
- design the feedback systems and PLLs (L3)
- analyze performance parameters linearity, noise and large signal performance (L1)
- design and analyze power amplifiers for HFS (L3)
- design and analyze oscillators for HFS (L3)

Unit V **8L**

MEMS technologies and components for RF applications: Micro fabrications for MEMS, materials for mems, RF MEMS switches, varactors, inductors and filters. Introduction to microwave antennas, definitions and basic principles.

Learning Outcomes:

After completion of this unit the student will be able to

- identify the materials for MEMS Explain the fabrication techniques of MEMS(L2).
- design RF MEMS switches (L3).
- design RF MEMS varactor (L3).
- design RF MEMS inductors (L3).
- explain the basic principles of microwave antennas (L2) .

Text Books:

1. DM Pozar, Microwave and RF Wireless Systems, New York, Wiley, 2001.
2. VK Varadan, K.J. Vinoy, K.A. Jose, RF MEMS and Their Applications, Wiley, 2003.

Reference Books:

1. Thomas H. Lee, The design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press, 2004.

Course Outcomes:

After successful completion of the course, the student will be able to

- predict and analyze the importance of RF AND MICROWAVE MEMS (L3).
- analyze the Behavior of passive IC components and networks (L1).
- explain the various types of transmission lines and waveguides (L2).
- demonstrate the operation of MEMS technologies & RF applications (L2).
- design of high frequency system in RF & Microwave MEMS (L3).

19EEC750: RADAR SYSTEMS

L	T	P	C
3	0	0	3

This course "Radar Systems" is aimed to understand the fundamental and essential topics required to design a Radar system. The subject mainly focuses on different types of Radar Systems, Radar Transmitters and Receivers based on application (military/civilian) and various design aspects required by a radar engineer.

Course Objectives:

- To familiarize the basic knowledge in Radar and its parameters
- To impart knowledge on the probability of detecting the targets and measuring range in spite of receiver noise.
- To derive the basic radar equation and its dependence on various parameters
- To study MTI and Pulsed Doppler radar system and its application.
- To study Doppler Effect and its applications with respect to pulsed Doppler radar.
- To understand moving target indicator and to study its application.
- To differentiate tracking techniques and scan methods.
- To study and understand the effect of noise on radar signal detection.

Unit I **8L**

Introduction: Basic Radar, simple form of radar equation, radar block diagram, radar Frequencies, applications of Radar. **The Radar Equation:** Detection of signals in noise, receiver noise and SNR, probability density functions, probability of detection and false alarm, integration of Radar pulses, Radar cross-section of targets, transmitter power, pulse repetition frequency.

Learning Outcomes:

After completion of this unit the student will be able to

- calculate Maximum Unambiguous Range, Radar Waveforms (L1).
- find Simple form of Radar Equation (L3).
- draw Radar Block Diagram and Operation (L2).
- find Transmitter Power, PRF and Range Ambiguities (L2).
- predict System Losses (qualitative treatment), Related Problems (L1).

Unit II **8L**

MTI and Pulse Doppler Radar: Introduction to Doppler and MTI radar, delay line cancellers, staggered pulse repetition frequencies, doppler filter banks, digital MTI processing, moving target detector, pulse doppler Radar.

Learning Outcomes:

After completion of this unit the student will be able to

- demonstrate MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter (L4).
- draw the Delay Line Cancellers – Filter Characteristics (L5).
- define Blind Speeds, Double Cancellation, Staggered PRFs. (L4).
- define Non-coherent MTI, MTI versus Pulse Doppler Radar (L6).

Unit III **8L**

Tracking Radar: Tracking with Radar, mono pulse tracking, conical scan and sequential lobbing, limitations to tracking accuracy, low-angle tracking, tracking in range, and comparison of trackers.

Learning Outcomes:

After completion of this unit the student will be able to

- understand different types in Tracking with Radar, Sequential Lobing, and Conical Scan (L7).
- understand the concept of Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates) (L7).
- analyze the concept of Phase Comparison Mono pulse, Target Reflection Characteristics and Angular Accuracy (L1).
- classify and define Tracking in Range, Acquisition and Scanning Patterns (L6).

Unit IV **8L**

Detection of Signals in Noise: Matched filter receiver, MF impulse response, derivation of MF frequency response, detection criteria, detectors, automatic detection, integrators, constant false alarm rate receivers, signal management.

Learning Outcomes:

After completion of this unit the student will be able to

- exemplifying the Introduction to Detection of Radar Signals in Noise (L2).
- evaluate the expression for Matched Filter Receiver (L6).
- understand the Matched Filter Receiver – Response Characteristics and Derivation (L2).
- evaluate the Correlation Function and Cross-correlation Receiver (L2).
- summarizing the Matched Filter with Non-white Noise (L8).

Unit V **8L**

Information from Radar Signals: Basic radar measurements, accuracy of radar measurements, time delay accuracy, ambiguity diagram, properties of ambiguity diagram, LFM pulse compression, binary phase coded pulse compression, target recognition, radar Clutter.

Learning Outcomes:

After completion of this unit the student will be able to

- apply Basic measurements to calculate time delay (L8).
- understand the ambiguity diagram to verify the Radar measurements (L8).

- analyze binary phase coded pulse compression, target recognition, radar Clutter (L2).

Text Books:

1. Merill Skolnik, Introduction to Radar Systems, 3/e, Tata Mc Graw Hill Publishers, 2003
2. Byron Edde, Radar: Principles, Technology, Applications, Pearson Education India, 2007

References

1. Fred E. Nathanson, J. Patrick Reilly, Marvin N. Cohen, Radar Design Principles, 2/e, McGraw Hill, 2006.
2. Mark A. Richards, Principles of Modern Radar – Basic Principles, Yesdee Publications, 2012.
3. Mark A. Richards, Principles of Modern Radar – Advanced Techniques, Yesdee Publications, 2014.

COURESE OUTCOMES:

After successful completion of the course, the student will be able to

- predict System Losses (qualitative treatment), Related Problems (L1).
- define Blind Speeds, Double Cancellation, Staggered PRFs (L2).
- understand the concept of Mono Pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates) (L3).
- understand the Matched Filter Receiver – Response Characteristics and Derivation (L4).
- understand the ambiguity diagram to verify the Radar measurements (L4).

19EEC752: MOBILE COMMUNICATIONS

L	T	P	C
3	0	0	3

This course introduces the student, the fundamental of mobile communication in communication engineering. the first unit cover the evaluation of cellular communication system, 2nd and 3rd gives the idea of cellular concept and type mobile communication system, 4th and 5th explain the channel characteristic and transport layer of mobile communication system.

Course objectives:

- To understand the basic cellular system concepts.
- To have an insight into the various propagation models and the speech coders used in mobile communication.
- To understand the multiple access techniques and interference eduction techniques in mobile communication.
- To understanding the basic principles of mobile communication systems.
- To analyze mobile communications with the interpretation of the call prints.
- To illustrate basic principles of the modern mobile and wireless communication systems.
- To understanding the operation of mobile communications systems and their generation.

Unit I **8L**

Introduction - Evolution of mobile radio communications, mobile radio systems around the world, trends in cellular radio and personal communication, first generation (1G), second generation (2G), third generation (3G) mobile cellular networks.

Learning Outcomes:

After completion of this unit the student will be able to

- discuss cellular radio concepts (L1)
- understand the Evolution mobile radio communication (L2)
- understand the personal communication (L2)
- distinguish among 1G, 2G and 3G cellular network (L3)
- discuss the cellular system design and technical challenges (L2)

Unit II **8L**

Cellular concept – Limitations of conventional mobile system, introduction to mobile cellular communication, concept of frequency reuse, cluster size, cellular system architecture, channel assignment strategies, call handoff strategies – hard handoff and soft handoff, prioritizing handoff; interference and system capacity, improving capacity in cellular systems – cell splitting, sectoring, microcell zone concept.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the concept of frequency reuse (L3).
- understand the cellular system architecture (L3).
- understand the channel assignment strategies and also able to differentiate different type of handoff strategies (L4).
- uistinguish among cell splitting and sectoring (L3).
- analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling (L5).
- analyze various methodologies to improve the cellular capacity (L4).

Unit III **8L**

Different mobile communication systems – GSM services and features, system architecture, GSM radio subsystem, GSM channel types, location updating and call setup, WAP, SCSD, GPRS, EDGE, 3G W-CDMA; CDMA digital cellular standard, comparison between GSM and CDMA, 3G cdma2000, IMT-2000.

Learning Outcomes:

After completion of this unit the student will be able to

- have knowledge of the mobile system specifications (L5).
- classify multiple access techniques in mobile communication (L5).
- outline cellular mobile communication standards (L6).
- understand the difference between GSM and CDMA (L5).
- understand the GSM,CDMA services and features (L6)
- analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts (L6).

Unit IV **8L**

Radio Channel Characterization – Free space propagation, Multipath propagation, diversity techniques, Co-channel interference, Propagation effects - scattering, ground reflection, fading, Log-normal shadowing.**Wireless networks** – Advantages and applications of Wireless LAN, WLAN technology – RF and IR wireless LAN, diffuse, quasidiffuse and point-to-point IR wireless LAN, IEEE802.11, IEEE802.11 architecture, physical layer, Mac layer, introduction to wifi, hiperlan2, Bluetooth – Bluetooth architecture.

Learning Outcomes:

After completion of this unit the student will be able to

- have knowledge about Free Space Propagation and Multipath Propagation (L6)
- understand the diversity techniques (L6)
- analyze the advantage and application of of Wireless LAN, WLAN technology (L7)
- understand the physical layer, Mac layer (L5)
- explain the Bluetooth architecture (L6)

Unit V **8L**

Mobile network and transport layer – Introduction to Mobile IP, requirements, IP packet delivery, agent discovery, registration, tunneling and encapsulation, optimization, reverse tunneling; mobile adhoc networks – routing, destination sequence distance vector, dynamic source routing and alternative metrics; traditional TCP – congestion control, slow start.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the Mobile IP requirements, IP packet delivery (L5).
- apply knowledge of TCP/IP extensions for mobile and wireless networking (L6)
- demonstrate basic skills for cellular networks design (L7).
- analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks (L7).
- analyze the dynamic source routing and alternative metrics (L7).

Text Books:

1. T. S. Rappaport, Wireless communications: principles and practice, Prentice Hall/Pearson Education, 2009.
2. J. Schiller, Mobile communications, Pearson Education, 2008.
3. Talukdar, Mobile computing, Tata Mcgraw Hill Publications, 2010.

Reference Books:

1. Mobile Cellular Communication, GottapuSasibhushana Rao, Pearson Education, New Delhi, 2013.
2. William C. Y. Lee, Mobile cellular telecommunication – analog and digital systems, McGraw Hill, 2nd ed.1995
3. Wang, Wireless communication System, Pearson Education, 2004
4. J.W.Mark, W. Zhuang, Wireless Communication and Networking, PHI, 2003.
5. A Santamaria et al, "Wireless LAN systems", Artech House, 2000.

COURESE OUTCOMES:

After successful completion of the course, the student will be able to

- understand the Evolution mobile radio communication (L2).
- understand the cellular system architecture (L3).
- analyze various methodologies to improve the cellular capacity (L4).
- understand the Mobile IP requirements, IP packet delivery (L5).
- understand the diversity techniques (L6)
- analyze the dynamic source routing and alternative metrics (L7).

19EEC754: GLOBAL POSITIONING SYSTEMS

L	T	P	C
3	0	0	3

This is an introductory course to basic principles of positioning features on the Earth's surface. Fundamentals of Global navigation satellite systems are developed. Different satellite constellations, data formats and Positioning Solution algorithm are elaborated. Different sources of errors and their mitigation techniques such as atmospheric errors, multipath errors and clock errors are discussed

Course objectives:

- To Introduce the basic principles of Global Positioning System and multi the satellite constellation
- To understand the signal structure and modulation schemes employed To study the characterization, generation and detection of various modulation schemes
- To understand different reference frames and coordinate systems of Positioning systems.
- To study about the GPS orbits and the satellite and Receiver position algorithm.
- To understand about the different error sources that effect the Positioning accuracy.

Unit-I **(8L)**

Overview of GPS: Basic concept, system architecture, space segment, user segment, GPS aided Geo-augmented navigation (GAGAN) architecture.

Learning Outcomes:

After completion of this unit the student will be able to

- understand basic concept of Global Positioning (L1).
- understand System architecture (L1).
- distinguish beteween the different segments of the architecture (L2).
- identify the necessity of augmented systems like GAGAN (L3).

Unit-II **(8L)**

GPS Signals and other constellations: Signal structure, anti-spoofing (AS), selective availability, multi constellation: GALILEO constellation and signal structure, GLONASS constellation and signal structure

Learning Outcomes:

After completion of this unit the student will be able to

- understand about the signal structure of the GPS (L4).
- identify the modulation schemes employed in navigation systems (L4).
- understand about the Galileo and GLONASS constellation (L2).
- differentiate the signal structure of the Galileo and GLONASS (L4).

Unit-III **(8L)**

GPS Coordinate Frames and Time References: Geodetic and geo centric coordinate systems, ECEF coordinate world geodetic 1984 (WGS 84), GPS time.

Learning Outcomes:

After completion of this unit the student will be able to

- well Aquitaine with different reference frames (L5).
- understand the coordinate systems of Positioning systems.(L5).
- differentiate the different coordinate systems.(L5).
- understand with GPS Time(L5).

Unit-IV **(8L)**

GPS Orbits and Satellite Position Determination: GPS orbital parameters, description of receiver independent exchange format (RINEX), observation data and navigation message data parameters, GPS position determination.

Learning Outcomes:

After completion of this unit the student will be able to

- well Aquitaine with satellite orbital parameters (L7).
- understand receiver independent exchange format (RINEX) (L6).
- identify orbital parameters from navigation message (L6).
- understand the observation data format (L6).
- understand the GPS Position determination algorithm (L7).

Unit-V **(8L)**

GPS Errors: GPS error sources – clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the different types of error sources (L7).
- estimate the ionospheric error using real time data (L7).
- model the troposheric error using realtime data (L7).
- model the multipath error using realtime data (L7).

Text Book(s)

1. B. Hoffman – Wellenhof, H. Liehtenegger, J. Collins, GPS: Theory and Practice, Springer – Wien, 2001.
2. Gottapu Sasibhushana Rao, Global Navigation Satellite Systems, Tata McGraw Hill Education, 2010.

References

1. B.Parkinson, J.Spilker, Jr., GPS: Theory and Applications, Vol. I, II, AIAA, 370 L'Enfant Promenade SW, Washington, DC 20024, 1996. 2. James Ba, Yen Tsui, Fundamentals of GPS Receivers: A Software Approach, John Wiley and Sons, 2001.

Course outcomes:

After successful completion of the course, the student will be able to

- describe the architecture of GPS.(L1)
- distinguish beteween the different segments of the architecture.(L2)
- explain the need of Augumentation systems.(L3)
- describe the signal structure of GPS and other navigation systems(l4)
- explain the need of reference frames and coordinate systems in Positioning systems(L5)
- process the navigation file to retrieve the orbital parameters (L6)
- describe the significance of orbital parameters in satellite systems (L7)
- estimate at least one /two errors with real time data and can compute the position.(L7)

19EEC756: WIRELESS CHANNELS AND UWB RADIO

L	T	P	C
3	0	0	3

This course presents the student, the overview of wireless communications in which the mechanism of cellular communications, propagation and various parameters of importance for wireless communications are highlighted in the first unit. MIMO systems and OFDM technology are explored in units two and three. Different coding principles for wireless communications are discussed in fourth unit. And the ultra wideband systems are explained in fifth unit.

Course Objectives:

1. To familiarize the cellular concepts, propagation, path loss models, time varying impulse response, fading and parameters that influence the wireless communications.
2. To explain multiple antenna and space time communications that include MIMO models, fading channels, space time modulation, ML detection and frequency selective channels.
3. To introduce and explain multicarrier modulation that involves overlapping carriers, discrete implementation of multi carrier modulation, DFT properties, OFDM generation using IFFT/FFT and peak to average power ratio.
4. To impart the knowledge about the coding in wireless communications that include LBC, convolutional codes, concatenated codes, turbo codes, LTPC codes, adaptive techniques, variable rate variable power MQAM and adaptive coded modulation.
5. To expose the concepts of ultra wide band systems, applications, properties, generation of waveforms, UWB transmitter and receiver and its application in LANS.

Unit I **8L**

Overview of Wireless Communications : Cellular telephone systems, Low cost, low power Radios: Blue tooth and Zigbee, Spectrum allocations for Existing systems, Free space path loss, Two ray model¸ Okumura and Hata Models, Simplified path loss model, Shadow fading, Combined path loss and shadowing, Time varying channel impulse response, narrowband/wideband fading models, Power delay profile, Coherence bandwidth, Channel coherence time, Delay spread and Doppler spread; Average probability of error in wireless channels for different modulation schemes and performance curves

Learning Outcomes

After completion of this unit the student will be able to

- analyze cellular communication systems (L1).
- determine the impulse response of time varying channels (L1).
- distinguish different path loss models in wireless communications (L1).
- identify and analyze different fading models (L2).
- predict the behavior of mobile channels with reference to parameters like delay spread, doppler spread, coherence time and coherence bandwidth (L2).

- evaluate probability of error for different modulation schemes in wireless communication systems (L2).

Unit II **8L**

Multiple Antenna and Space-Time Communications: Narrowband MIMO model, parallel decomposition of MIMO channel, MIMO channel capacity: static and fading channels, MIMO diversity gain: Beam forming, space-time modulation and coding: ML detection, rank and determinant criteria, space-time trellis and block codes Spatial Multiplexing and BLAST architectures, frequency-selective MIMO channels, smart antennas

Learning Outcomes:

After completion of this unit the student will be able to

- analyse narrow band MIMO model and understand parallel decomposition of MIMO cahnnel (L3).
- evaluate MIMO channel capacity and diversity gain (L3).
- understand space-time modulation, coding and ML detection (L2).
- assess the importance of space time trellis and block codes (L2).
- distinguish space time multiplexing and BLAST architecture (L3).
- appreciate the role of smart antenna in these systems (L3).

Unit III **8L**

Multi Carrier Modulation : Data transmission using multiple carriers, multicarrier modulation with overlapping sub channels, mitigation of subcarrier fading: frequency equalization, pre coding, adaptive loading, Discrete implementation of Multicarrier modulation: The DFT and its properties, the cyclic prefix, Orthogonal Frequency Division multiplexing (OFDM): OFDM with IFFT/FFT implementation, Matrix representation of OFDM: vector coding, challenges in multicarrier systems: Peak to average power ratio, Frequency and timing offset, case study: The IEEE802.11a Wireless LAN standard

Learning Outcomes:

After completion of this unit the student will be able to

- analyse how multi carriers are employed for data transmission (L3).
- understand multi carrier modulation with overlapping sub channels (L4).
- appreciate the role of DFT and its properties (L4).
- explain the concept of OFDM and implement the OFDM with IFFT/FFT (L4).
- identify matrix representation of OFDM and vector coding (L5).
- analyse the concept of peak to average power ratio and frequency and timing offset (L5).

Unit IV **8L**

Coding for wireless channels and Adaptive Modulation: Linear block codes, convolutional codes and concatenated codes, turbo codes and LDPC codes, coded modulation, coding with interleaving for fading channels, unequal error protection codes, adaptive transmission system, adaptive techniques, variable-rate variable-power MQAM: Adaptive rate and power techniques, channel inversion with fixed rate, discrete-rate adaptation, channel estimation and error delay, adaptive coded modulation

Learning Outcomes:

After completion of this unit the student will be able to

- analyze the importance of coding in wireless channels (L4).
- distinguish various codes such as LBC, Convolutional codes, turbo codes, LDPC codes (L4).
- explain coding with interleaving for fading channels (L4).
- understand the necessity of adaptive techniques (L4).
- analyze variable rate variable power MQAM (L5).
- estimate the channel and error delay (L4).
- explain the importance of adaptive coded modulation (L4).

Unit V **8L**

Ultra Wideband (UWB) Systems: Basic definitions and benefits of UWB, Basic properties of UWB signals: Power spectral density, pulse shape, pulse trains, Spectral Masks, Multipath, Speed of data transmission, power consumption, Generation of UWB waveforms: Damped sine waves, Gaussian waveforms, UWB transmitter and receiver, UWB in WLANS.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the basic concepts of ultra wideband radio and its properties (L5).
- analyse the concepts of PSD, pulse shape, pulse trains and spectral masks (L5).
- understand speed of data transmission in UWB and power consumption (L5).
- identify the generation of UWB waveforms, damped sine waves and Gaussian waveforms (L5).
- explain the UWB transmitter and Receiver (L5).

Text Book(s)

1. Wireless Communications, Andrea Goldsmith, Cambridge University press

2. M. Ghavami, L. B. Michael, R. Kohno, Ultra Wideband Signals and Systems in Communication Engineering, John Wiley & Sons, Ltd., 2007.

Course Outcomes:

After successful completion of the course, the student will be able to

- predict and analyse time varying impulse response of mobile channels, power delay profile and role of delay spread, Doppler spread, coherence time and coherence bandwidth in the design of mobile communication systems (L1).
- analyse MIMO channels, their capacity, space time modulation, coding band related issues with MIMO channels (L2).
- demonstrate the importance of multi carrier modulation, implementation of OFDM using IFFT/FFT, PAPR and frequency and time offset (L3).
- appreciate the role of coding in wireless channels, and construct different codes such as LBC, LDPC, Convolutional and turbo codes (L4).
- analyse and explain the concepts of UWB radio, its properties, waveforms , transmission and reception of UWB (L5).

19EEC758: WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

The emphasis of this course is on the use of a wireless sensor networks in the present day of the market. This course provides the knowledge of architecture of wireless sensor network and challenges in them. The students are exposed to the protocols used at different layers such as physical, network and transportation layer. The emphasis will be laid on data aggregation and the advantage of wireless sensor networks.

Course Objectives:

- To provide an understanding on basic sensor networks and radio technologies.
- To analyze the design issues in medium access control protocols related to different layers of sensor networks.
- To analyze the design issues in routing protocols related to different layers of sensor networks.
- To analyze the design issues in transport control protocols of sensor networks.
- To learn about various applications of network management.

Unit I **8L**

Introduction to Wireless Sensor Networks: Basic Sensor Network Architectural Elements, Sensor Node Technology Overview, Hardware and Software, WN Operating Environment, , WN Trends**, Radio Technology**: Propagation and Propagation Impairments, Modulation, Available Wireless Technologies.

Learning Outcomes:

After completion of Module I, student will be able to

- define wireless sensor network (L1).
- analyze the challenges of sensor networks (L4).
- identify the enabling technologies that are suitable for wireless sensor networks (L1).
- examine the factors influencing WSN design (L4).

Unit II **8L**

Medium Access Control Protocols for Wireless Sensor Networks: Fundamentals of MAC Protocols, MAC Protocols for WSNs: Schedule-Based Protocols, Random Access-Based Protocols, Sensor-MAC case study, **The IEEE 802.15.4 MAC protocol**: PHY Layer, MAC Layer

Learning Outcomes:

After completion of Module II, student will be able to

- understand the architecture and components used in WSN (L1).
- analyze the MAC protocols in the design of WSN(L4)
- examine the problems associated with types of MAC in WSN (L4).

- understand the layer topologies of WSN (L1).

Unit III **8L**

Routing Protocols for Wireless Sensor Networks: Routing Challenges and Design Issues in Wireless Sensor Networks, Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, WSN Routing Techniques, Flooding and Its Variants, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering, Geographical Routing.

Learning Outcomes:

After completion of Module III, student will be able to

- understand the issues in designing for wireless sensor networks (L1).
- compare the different routing techniques used in WSN (L4).
- understand the issues in designing routing protocols for wireless sensor networks (L1).
- summarize the various methods of protocols used in WSN (L4).

Unit IV **8L**

Transport control Protocols for WSN: Traditional Transport Control Protocols: TCP (RFC 793), 231 7.1.2 UDP (RFC 768), Feasibility of Using TCP or UDP for WSNs, Transport Protocol Design Issues, Existing Transport Control Protocols: CODA, RMST,ATP, Performance of Transport Control Protocols.

Learning Outcomes:

After completion of Module IV, student will be able to

- define the concept of Traditional Transport Control Protocols (L1).
- explain various types of TCPs (L2).
- explain performances of TCPs (L2).
- demonstrate the challenges in TCPs (L3).

Unit V **8L**

Network Management and applications: Network Management Requirements and models, design Issues, MANNA, **WSN applications:** Sensor and Robots, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Industrial Automation, Medical Applications.

Learning Outcomes:

After completion of Module V, student will be able to

- summarize the architecture and design aspects in Network management (L4).
- differentiate between different models of network management (L4).
- identify the sensors and robot applications used in WSN (L1).
- analyze various real time applications of network management (L4).

Text Book(s)

1. Kazem Sohraby, Daniel Minoliand Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2. Anna Hac, "Wireless Sensor Network Designs", John Wiley and Sons Ltd,

References

1. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

Course Outcomes:

After completing this course the student will be able to

- illustrate the Concepts of Network Architecture and Applications of Wireless Sensor Networks (L1).
- analyze the protocol design issues of wireless sensor networks (L4).
- compare different routing protocols of MAC layer and network layer for wireless sensors networks (L4).
- summarize the concept of Traditional Transport Control Protocols (L2).
- understand the applications of network management (L1).

19EOE742: BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

This course introduces students to the science of business analytics. The goal is to provide students with the foundation needed to apply data analytics to real-world challenges they confront daily in their professional lives. Students will learn to identify the ideal analytic tool for their specific needs; understand valid and reliable ways to collect, analyze, and visualize data; and utilize data in decision making for managing agencies, organizations or clients in their workspace

Course Objectives:

- To familiarize the scope, process and advantages of business analytics
- To acquaint the student with the modeling and problem solving skills in business analytics
- To impart the organization and management of business analytics
- To introduce the forecasting models and techniques used in analytics
- To expose the formulation and decision strategies used in business analytics

Unit I **8L**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the scope and process of business analytics (L1).
- choose an organizational structure to implement a business analytics process (L4).
- describe the statistical tools and methods used for data modeling and analysis (L2).
- identify the sampling and estimation requirements for data analysis (L1).

Unit II **8L**

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Learning Outcomes:

After the completion of this unit, the student will be able to

- identify the relationships and trends in data (L1).
- utilize linear regression methods for identifying data relationships (L4).
- list the types of data and their models used for business analytics (L1).
- describe the methods for visualization and exploration of data (L2).

Unit III **8L**

Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the management issues in the organization structures (L2).
- define the designing information policy and its usage (L1).
- list the methods for ensuring data quality measuring contribution (L1).
- explain the use of data mining methodologies for predictive analytics analysis (L3).
- describe the use of prescriptive analytics methods in business analytics process (L2).

Unit IV **10L**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Learning Outcomes:

After the completion of this unit, the student will be able to

- classify and describe the use of forecasting models (L3).
- model the use of regression forecasting with casual variables (L5).
- identify the appropriate forecasting model for a given data (L5).
- explain the use of monte carlo simulation for forecasting and identify the involved risk (L2).

Unit V **8L**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Learning Outcomes:

After the completion of this unit, the student will be able to

- formulate decision problems (L2).
- list the decision strategies with and without probabilities (L1).
- use the decision trees for analysis (L4).
- describe the value of information, utility and its use in decision making (L4).

Textbook(s):

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications Pearson FT Press, 2014.
2. James Evans, Business Analytics, Pearson Education, 2013.

Course Outcomes:

Upon successful completion of the course, the student will be able to

- define the scope, process and advantages of business analytics (L1).
- explain the modeling and problem solving skills in business analytics (L2).
- describe the organization and management of business analytics (L3).
- utilize the forecasting models and techniques used in analytics (L4).
- enumerate and utilize the formulation and decision strategies (L2).

19EOE744: INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

Safety by design or prevention through design is in the core for maintaining engineering systems safe. The students will be equipped with concepts of engineering systems safety, dimensions of engineering systems safety, safety design and analysis mathematics, design for engineering systems safety and control for safety, and integrating safety with other operational goals such as quality and reliability

Course Objectives

- to impart knowledge on different facets and aspects of industrial systems safety
- to familiarize the student with tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings
- to impart the knowledge of definition, function and types of maintenance activities
- to familiarize the different wear and corrosion mechanisms and their prevention methods
- to expose the students to different faults and their tracing mechanisms
- to impart the art of planning periodic and preventive maintenance mechanisms

Unit I **8L**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the different types of mechanical and electrical hazards in industrial systems(L1)
- enumerate the salient points of factories act 1948(L2)
- describe the health and safety measures to be enforced for industrial safety(L3)
- elaborate the different fire prevention and firefighting arrangements to be made(L2)

Unit II **8L**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning and aim of maintenance engineering(L1)
- elaborate the primary and secondary functions of maintenance department(L2)
- classify the different types and applications of maintenance(L3)
- relate the replacement economy with maintenance cost(L5)
- estimate the service life of equipment from the specifications of individual components(L4)

Unit III **8L**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear (L2).
- elaborate the different methods for reducing wear (L2).
- list the different types of lubricants and mention their applications (L1).
- define the principle and factors affecting corrosion (L1).
- classify the different types of corrosion and identify their prevention methods (L3).

Unit IV **8L**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear (L2).
- use the concept of decision tree for fault tracing in machine tools (L4).
- build decision trees for different machine tools including pump, air compressor etc (L4).
- classify the different types of faults in machine tools and their causes (L3).

Unit V **10L**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the concept of periodic inspection and its need (L2).
- list the common troubles and remedies of electric motor (L1).
- define the need for preventive maintenance and list its steps (L3).
- elaborate the steps/procedure of periodic and preventive maintenance of diesel generating sets, pumps etc (L2).

Text Book(s):

1. Lindley R. Higgins, Lester Coridon Morrow, Maintenance Engineering Handbook, Da Information Services, 1977.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987.
3. Audels, Pump-hydraulic Compressors, Mc Graw Hill Publication, 1992.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975

Course Outcomes:

Upon successful completion of the course, the student will be able to

- describe the different facets and aspects of industrial systems safety (L2).
- demonstrate the use of tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings (L4).
- define the function and list the types of maintenance activities (L1).
- describe the concept of wear and corrosion mechanisms and their prevention method (L2).
- enumerate the different faults and their tracing mechanisms (L3).
- elaborate the planning periodic and preventive maintenance mechanisms needed for industrial safety (L4).

19EOE746: OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.

Course Objectives:

- To impart knowledge on developing mathematical formulation for linear programming and transportation problem
- To familiarize the student in the construction of the required activities in an efficient manner to complete it on or before a specified time limit and at the minimum cost.
- To expose the development of mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
- To illustrate PERT and CPM techniques for planning and implementing projects.
- To impart the knowledge of formulating and analysis of real life problems using advanced tools and techniques for resource optimization
- To provide frameworks for analyzing waiting lines using advanced queuing theory concepts

Unit I **8L**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Learning Outcomes:

After completing this unit, the student will be able to

- identify and develop operational research models from the verbal description of the real system (L4).
- understand the classification systems of effective Inventory control models (L2).

Unit II **8L**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Learning Outcomes:

After completing this unit, the student will be able to

- translate a real-world problem, given in words, into a mathematical formulation (L2)
- utilize the mathematical tools that are needed to solve optimization problems (L2)

Unit III **8L**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Learning Outcomes:

After completing this unit, the student will be able to

- describe the need and origin of the optimization methods (L2).
- classify optimization problems to suitably choose the method needed to solve the particular type of problem (L3).

Unit IV **8L**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Learning Outcomes:

After completing this unit, the student will be able to

- choose linear programming problems to suitably choose the method needed to solve the particular type of problem (L1).
- identify industrial problems involved in inventory, MRP and scheduling (L2).

Unit V **8L**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Learning Outcomes:

After completing this unit, the student will be able to

- identify the values, objectives, attributes, decisions, uncertainties, consequences, and trade-offs in a real decision problem (L2).
- apply the models to incorporate rational decision-making process in real life situations (L3).
- analyze various modeling alternatives & select appropriate modeling techniques for a given situation (L3).

Text Book(s):

1. H.A. Taha, Operations Research, An Introduction, Prentice Hall of India, 2008
2. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, 2008
4. Hitler Libermann Operations Research: McGraw Hill Publishers, 2009
5. Pannerselvam, Operations Research: Prentice Hall of India, 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India, 2010

Course Outcomes:

After the successful completion of the course, the students will be able to

- Understand the basic concepts of different advanced models of operations research and their applications (L2).
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action (L4).
- Apply the models to incorporate rational decision-making process in real life situations (L4).
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation (L3).
- Validate output from model to check feasibility of implementations (L5).
- Create innovative modeling frameworks for a given situation (L6).
- Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship (L3).

19EOE748: COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

This course will equip the student with the expertise to mathematically model engineering projects and use effective methods and techniques to plan and execute engineering activities.

Course Objectives:

- To introduce the basic principles of strategic cost management and the related terminology
- To familiarize the project planning and execution process involving technical/nontechnical activities
- To acquaint the student with detailed engineering activities and their cost management analysis
- To impart the knowledge of cost analysis and profit planning of engineering projects
- To familiarize the quantitative techniques for optimization of budget allocation

Unit I **8L**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the cost concepts in decision making (L2).
- define the various costs involved in the cost management process (L2).
- list the objectives of cost control (L2).
- identify the different fields of a database for operational control (L2).

Unit II **8L**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

Learning Outcomes:

After the completion of this unit, the student will be able to

- define the meaning of a project and list the different types (L2).
- identify the measures to manage cost overruns (L2).
- describe the various stages of project execution from conception to commissioning (L2).
- plan the proper order of technical/nontechnical activities as part of project execution (L2).

Unit III **8L**

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Learning Outcomes:

After the completion of this unit, the student will be able to

- identify the different clearance norms required in the pre-project execution phase (L2).
- describe the hierarchy of project team and identify the role of each member (L2).
- list the different contents of project contracts (L2).
- present the project cost control and planning through bar charts, network diagrams etc (L2).

Unit IV **8L**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

Learning Outcomes:

After the completion of this unit, the student will be able to

- describe the cost behavior and profit planning (L2).
- distinguish between marginal costing and absorption costing (L2).
- analyze the variance of standard costing (L2).
- analyze the pricing strategies in project costing (L2).
- identify the quality measures satisfying the appropriate constraints (L2).

Unit V **10L**

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory

Learning Outcomes:

After the completion of this unit, the student will be able to

- define and compare the different budgeting strategies (L2).
- model the cost management as a linear programming problem (L2).
- measure the divisional profitability and decide the appropriate pricing (L2).

Textbook(s):

1. Charles T. Horngren, Srikant M. Datar, George Foster, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2006.

References:

1. Charles T. Horngren, George Foster, Advanced Management Accounting, Greenwood Publishing, 2001.
2. Robert S Kaplan, Anthony A. Alkinson, Management & Cost Accounting, 1998.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, Wheeler Publisher, 2004.
4. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book, 2006.

Course Outcomes:

After the successful completion of the course, the students will be able to

- list the basic principles of strategic cost management and define the related terminology (L1).
- plan the project execution process involving technical/nontechnical activities (L4).
- describe the detailed engineering activities and their cost management analysis (L2).
- carry out the cost analysis and profit planning of engineering projects (L5).
- utilize quantitative techniques for optimization of budget allocation (L6).

19EOE752: WASTE TO ENERGY

L	T	P	C
3	0	0	3

This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements.

Course Objectives:

- to introduce the classification of waste for its usefulness in preparing different fuels
- to familiarize the biomass pyrolysis process and its yield issues
- to acquaint the student with biomass gasification processes and construction arrangements
- to impart the types and principles of biomass combustors
- to familiarize the calorific values and composition of biogas resources

Unit I **8L**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Learning Outcomes:

After the completion of this unit, the student will be able to

- distinguish between different types of waste (L1).
- classify the different types of waste for manufacturing different types of fuel (L3).
- identify the different conversion devices and their applications (L4).

Unit II **8L**

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Learning Outcomes:

After the completion of this unit, the student will be able to

- classify the different types of pyrolysis methods based on speed (L1).
- describe the different methods of manufacturing charcoal (L2).
- explain the chemical processes involved in the manufacture of pyrolytic oils and gases (L2).

Unit III **8L**

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the design, construction and operation of different gasifiers (L2).
- describe the burner arrangement for thermal heating (L2).
- elaborate the gasifier engine arrangement for equilibrium and kinetic considerations (L3).

Unit IV **8L**

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Learning Outcomes:

After the completion of this unit, the student will be able to

- explain the basic principle of biomass combustors (L2).
- classify different combustors based on their capacity and efficiency (L3).
- describe the construction and operation of fixed bed inclined grate, fluidized bed combustors (L2).

Unit V **10L**

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Learning Outcomes:

After the completion of this unit, the student will be able to

- list the properties of biogas (L1).
- elaborate the design, construction and operation of biogas plant (L2).
- classify the different biomass resources and their conversion process (L3).
- distinguish between different biogas plants and identify their applications (L5).

Text Book(s)

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Outcomes:

After the successful completion of the course, the student will be able to

- classify different types of waste for their usefulness in preparing different fuels (L3).

- describe the biomass pyrolysis process and its yield issues (L2).
- outline the different biomass gasification processes and their construction arrangements (L3).
- explain the types and principles of biomass combustors (L2).
- analyze the calorific values and composition of biogas resources (L5).

19EEC792: TECHNICAL SEMINAR

L T P C

0 0 4 2

Each student shall survey a technical topic related to a chosen specialization and prepare/submit a report in a specified format. Each student has to prepare a power point presentation on a selected technical topic with a novelty and get it evaluated by the faculty assigned for this purpose.

19EEC722: MICROWAVE CIRCUIT DESIGN LABORATORY

Course Objectives:

1. To Learn about AWR Microwave Office Software
2. To design different amplifiers using AWR Microwave Office Software
3. To find out frequency response of FET
4. To design different microwave components
5. To design the layout of passive circuits.

List of Experiments

Design and Simulation of the following microwave circuits using AWR Microwave Office Software

1. Design of IF amplifier
2. Design of Mixer
3. Design of low noise amplifier
4. Design a sub circuit of a microwave circuit.
5. Design of Power amplifier
6. Design of Microwave components and passive circuits
7. Design of E, H junctions.
8. Impedance calculation of transmission line.
9. Frequency response of FET
10. Design layout of passive circuit.
11. Design Magic-T junctions.
12. Design of Microwave filters

Course Outcomes:

1. Design any type of amplifiers using AWR Microwave Office Software
2. Find out frequency response of FET
3. Design and analyze different microwave components
4. Design the layout of passive circuits.

19EEC724: ANTENNA DESIGN AND SIMULATION LABORATORY

L	T	P	C
0	0	4	2

Course Objectives:

1. To Learn about **MATLAB/Ansoft HFSS** Software
2. To Simulate different antennas and find out the radiation characteristics
3. To Design different antennas in both the softwares and compare the parameters

List of Experiments

Design and Simulation of the below antennas shall be carried out using **MATLAB/Ansoft HFSS** Software

1. Dipole Antenna
2. Horn Antenna
3. Endfire Antenna Array
4. Rectangular Waveguide
5. Probe Feed Patch Antenna
6. Triangular microstrip antenna
7. Stripline

Course Outcomes:

Successful completion of the course, the student will be able to

1. Design any type of antenna using **MATLAB/Ansoft HFSS** Software
2. Simulate different antennas and find out the radiation characteristics
3. Design different antennas in both the softwares and compare the parameters

19EEC891: PROJECT WORK I

L	T	P	C
0	0	26	13

Each student is required to submit a report of first part of project work i.e. about the problem definition, literature review and methodology to be adopted including experiments and tests to be performed on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester end.

19EEC892: PROJECT WORK II

L	T	P	C
0	0	26	13

Each student is required to submit a detailed project report about the work on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester and Final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time. The candidate shall present/publish one paper in national/international conference/seminar/journal of repute. However, candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.