



INSTITUTE VISION

"To be a preferred institution in Engineering Education by achieving excellence in teaching and research and to remain as a source of pride for its commitment to holistic development of individual and society"

INSTITUTE MISSION

"To continuously strive for the overall development of students, educating them in a state of the art infrastructure, by retaining the best practices, people and inspire them to imbibe real time problem solving skills, leadership qualities, human values and societal commitments, so that they emerge as competent professionals"

DEPARTMENTAL VISION

"To be the centre of excellence in providing education in the field of Electronics and Communication Engineering to produce technically competent and socially responsible engineering graduates."

DEPARTMENTAL MISSION

"Educating students to prepare them for professional competencies in the broader areas of the Electronics and Communication Engineering field by inculcating analytical skills, research abilities and encouraging culture of continuous learning for solving real time problems using modern tool".



PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1:

Acquire core competence in Applied Science, Mathematics, and Electronics and Communication Engineering fundamentals to excel in professional carrier and higher study.

PEO2:

Design, Demonstrate and Analyze the Electronic Systems which are useful to society.

PEO3:

Maintain Professional and Ethical values, Employability skills, Multidisciplinary approach and an Ability to realize Engineering issues to broader social contest by engaging in lifelong learning.

PROGRAM SPECIFIC OUTCOMES(PSOS)

The graduates will be able to:

PSO1:

An ability to understand the concepts of Basic Electronics and Communication Engineering and to apply them to various areas like Signal Processing, VLSI, Embedded Systems, Communication Systems and Digital & Analog Devices

PSO2:

An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive at cost effective and appropriate solutions



PROGRAM OUTCOMES(POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



STUDENT HELP DESK

Sl.No	Name of the faculty	Activities
1	Dr. M. C. Sarasamba	GATE / Pre-Placement Coaching
		Students Mentor
		Module Coordinator
		Research Center Coordinator
		Dept. NAAC Criteria Sub Coordinator
		NBA Criteria Coordinator
2	Dr. S. S. Itannavar	Dean Students Welfare
		GATE / Pre placement Coaching
		BSP /DSP Lab In charge
		Students Mentor
		Module Coordinator
		ISTE Convener & Dept. Coordinator
		NBA /NAAC Criteria Coordinator
		AICTE Coordinator
3	Dr. B. I. Kattimani	GATE / Pre-Placement Coaching
		NBA Criteria Coordinator
		Module Coordinator
		Students Mentor
		Internship Coordinator
		Communication Lab In charge
4	Prof. S. S. Malaj	GATE / Pre- Placement Coaching
		Adv. Comm. Lab In charge
		Central Counseling Coordinator
		Students Mentor
		NAAC Criteria Sub Coordinator
		NBA Criteria Coordinator
		Class Teacher V- Sem B Div
		Library Committee Member
		NIRF Coordinator
5	Prof. S. S. Kamate	GATE / Pre placement Coaching
		VLSI Lab In charge
		Students Mentor
		Module Coordinator
		IEEE Coordinator/ IA Coordinator
		Dept. NAAC Criteria Sub Coordinator
		Project Coordinator
		Class Teacher V- Sem A Div
		NBA Criteria Coordinator



Sl.No	Name of the faculty	Activities
6	Prof. D. M. Kumbhar	GATE / Pre placement Coaching
		IOT Lab In charge
		Students Mentor
		Dept. Association Coordinator
		Class Teacher III Sem A- Div
		IIIC Coordinator
		Dept. NAAC Criteria Sub Coordinator
		NBA Criteria Coordinator
		Institute & Dept. ED Cell Coordinator
7	Prof. S. S. Patil	GATE / Pre placement Coaching
		ARM & ES Lab In charge
		Students Mentor
		NAAC Criteria 7 Convener
		NBA Criteria Coordinator
		Admission Coordinator
		Module Coordinator
8	Prof. D. B. Madihalli	GATE / Pre placement Coaching
		DSD Lab In charge
		UHV Coordinator
		Students Mentor
		NBA / NAAC Coordinator
		News & Publicity Coordinator
		NBA Criteria Coordinator
		Website Coordinator
		VTU LIC Coordinator
9	Prof. P. V. Patil	GATE / Pre placement Coaching
		E- Yantra Lab In charge
		Students Mentor
		NBA /NAAC Criteria Coordinator
		Dean TP& IIIC Cell
		SPOC PMV & PMKEY
		Alumni Coordinator



Sl.No	Name of the faculty	Activities
10	Prof. B. P. Khot	GATE / Pre placement Coaching
		MC Lab In charge
		Students Mentor
		Dept. Time Table Coordinator
		Dept. Meeting Coordinator
		Class Teacher VII Sem
		NBA/NAAC Criteria Coordinator
		Dept T&P Cell Coordinator
		Seminar Coordinator
11	Prof. S. R. Mallurmath	EMS Coordinator
		ERP Coordinator
		GATE / Pre placement Coaching
		Students Mentor
		News Letter / Technical Magazine
		Class Teacher III Sem B Div
		NBA/NAAC Criteria Coordinator
12	Prof. K. S. Patil	GATE / Pre placement Coaching
		Students Mentor
		NBA /NAAC Criteria Coordinator
		AICTE Activity Coordinator
13	Prof. S. M. Patil	GATE / Pre placement Coaching
		Students Mentor
		EMS Coordinator
		NBA Criteria Coordinator



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**Course Plan 2025-26 Odd– Semester - 7th
Electronics & Communication Engineering**

DEPARTMENTAL RESOURCES

Department of Electronics and Communication Engineering was established in the year 1996 and is housed in total area of 1112.83 Sq. Mtrs.

FACULTY POSITION

S.N.	Category	No. in position	Average experience
1	Teaching faculty.	13	18.64Y
2	Technical supporting staff.	03	24.02Y
3	Helper staff	02	23.03Y

MAJOR LABORATORIES

S. N.	Name of the laboratory	Area in Sq. Mtrs	Amount Invested in Lakhs	S. N.	Name of the laboratory	Area in Sq. Mtrs	Amount Invested in Lakhs
1	Digital Electronics Lab	71	1.54	5	VLSI /HDL Lab	71	47.69
2	Analog Electronics Lab	92	8.24	6	Project Lab	95	--
3	Advanced Commn & Commn + LIC Lab	92	20.01	7	Research/E-Yantra / C.N. Lab	71	9.86
4	DSP/MC / EMD Lab	71	17.50	8	Power Electronics Lab	--	4.86
Total Investment in The Department Rs. 109.73 Lacs							

TEACHING FACULTY DETAILS

Sl. No.	Name	Designation	Qualification	Specialization	Professional Membership	Teaching Exp.	Contact No.
1	Dr. M. C. Sarasamba	Prof. & HOD	Ph.D	Micro strip Antenna	LMISTE	21Y.00M	9480714746
2	Dr. S .S .Ittannavar	Assoc. Prof	Ph.D	DSP	LMISTE	12Y.06M	9964299498
3	Dr. B. I. Kattimani	Assoc. Prof	Ph.D	Micro strip Antenna	LMISTE	16Y.06M	9060467209
4	Prof. S. S. Malaj	Asst. Prof	M.E.	E & TC	LMISTE	28Y.02M	9731795803
5	Prof. S. S. Kamate	Asst. Prof	M.Tech	Digital Electronics	LMISTE	22Y.07M	9008696825
6	Prof. D.M. Kumbhar	Asst. Prof	M.Tech	Electronics	LMISTE	21Y.06M	09373609880
7	Prof. S .S. Patil	Asst. Prof	M.Tech	VLSI & Embedded	LMISTE	21Y.03M	9448102010
8	Prof. D.B. Madihalli	Asst. Prof	M.Tech	Industrial Electronics	LMISTE	18Y.02M	9902854324
9	Prof. P. V. Patil	Asst. Prof	M.Tech	VLSI & Embedded	LMISTE	13Y.00M	9731104059
10	Prof. B. P. Khot	Asst. Prof	M.Tech	Microelectronics & Control Systems	--	9Y.06M	9964019501
11	Prof. S. R. Mallurmath	Asst. Prof	M.Tech	Industrial Electronics	LMISTE	12Y.06M	7259865769
12	Prof. K. S. Patil	Asst. Prof	M.Tech	VLSI	LMISTE	31Y.00M	9902682781
13	Prof. S. M.Patil	Asst. Prof	M.Tech	VLSI& EMD	--	02Y.06M	9986238640

TECHNICAL SUPPORTING STAFF

S.N.	Name	Qualification	Experience	S.N.	Name	Qualification	Experience
1.	Sri. P. S. Desai	DEC	25Y-.00M	3.	Sri. R. B. Todkar	DEC	25Y-00M
2.	Sri. M. A. Attar	DEC	15Y-03M	4.	Sri. M.S. Byali	DEC	15Y-03M



**Course Plan 2025-26 Odd– Semester - 7th
Electronics & Communication Engineering**

Annexure-I 5

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Communication Engineering

Scheme of Teaching and Examinations 2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

VII SEMESTER (Swappable VII and VIII SEMESTER)													
Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	IPCC	BEC701	Microwave Engineering and Antenna Theory		3	0	2		03	50	50	100	4
2	IPCC	BEC702	Computer Networks and Protocols		3	0	2		03	50	50	100	4
3	PCC	BEC703	Wireless Communication Systems		4	0	0		03	50	50	100	4
4	PEC	BEC714x	Professional Elective Course		3	0	0		03	50	50	100	3
5	OEC	BEC755x	Open Elective Course		3	0	0		01	50	50	100	3
6	PROJ	BEC786	Major Project Phase-II		0	0	12		03	100	100	200	6
										350	350	700	24
Professional Elective Course													
BEC714A		Application Specific Integrated Circuit		BEC714C	Automotive Electronics								
BEC714B		Cyber Security		BEC714D	Radar Communication								
Open Elective Course													
BEC755A		E-waste Management		BEC755C	Embedded System Applications								
BEC755B		Automotive Electronics		BEC755D	Sensors and Actuators								
PCC: Professional Core Course, PCCL: Professional Core Course laboratory, PEC: Professional Elective Course, OEC: Open Elective Course PR: Project Work, L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. TD- Teaching Department, PSB: Paper Setting department, OEC: Open Elective Course, PEC: Professional Elective Course. PROJ: Project work													
Note: VII and VIII semesters of IV years of the program (1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester. (2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.													



Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK (21XXP75): The objective of the Project work is

- (i) To encourage independent learning and the innovative attitude of the students.
- (ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.
- (iii) To impart flexibility and adaptability.
- (iv) To inspire team working.
- (v) To expand intellectual capacity, credibility, judgment and intuition.
- (vi) To adhere to punctuality, setting and meeting deadlines.
- (vii) To install responsibilities to oneself and others.
- (viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.



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COMPREHENSIVE CALENDAR OF EVENTS (CoE) FOR THE AY: 2025-26
AND CoE FOR THE SUMMER SEMESTER OF AY: 2024-25

(Regular Odd Sems.: V & VII, w.e.f.: 4th Aug. 2025, Published on: 24th July 2025)

- Ref: 1. VTU CoE Notification No.: VTU/BGM/BoS/Academic Calendar/2024-25/1588, Dated : 12th July 2025
 2. VTU Summer Semester CoE Notification No.: VTU/BGM/BoS/Academic Calendar/2024-25/1657, Dated : 15th July 2025
 3. VTU Holiday Notification No.: VTU/BGM/Est/CR (4)/2024-25/1580, Dated : 10th Dec. 2024

Calendar							Date	Events & Holidays
August -2025							4 th Aug. 2025	Commencement of Regular V & VII and Summer Semester Classes for Registered Courses (Ref.2)
Sun	Mon	Tue	Wed	Thu	Fri	Sat	22 nd -23 rd Aug. 2025	1 st IA Test & CCAs of Summer Sem. (On 02 COs)
31					1	2	23 rd Aug. 2025	1 st Feedback on T & L of Summer Sem
3	4	5	6	7	8	9	25 th Aug. 2025	Display of 1 st IA Test & CCAs Marks of Summer Sem.
10	11	12	13	14	15	16	23 rd Aug. 2025	Ideathon & Project Synopsis Presentation (Mini & Major)
17	18	19	20	21	22	23	11 th -12 th Sept. 2025	2 nd IA Test & CCAs of Summer Sem. (On remaining 03 COs)
24	25	26	27	28	29	30	12 th Sept. 2025	2 nd Feedback on T & L of Summer Sem
15 th GH: Independence Day							13 th Sept. 2025	Display of 2 nd IA Test & CCAs Marks of Summer Sem.
18 th LH: Shrawan Last Monday (Tentative)							13 th Sept. 2025	Last Working Day of the Summer Semester
27 th GH: Varasidhi Vinayaka Vratha							11 th -13 th Sept. 2025	1 st IA Test of Regular V & VII Sems. (On 01 CO)
September -2025							13 th Sept. 2025	1 st Feedback on T & L of Regular V & VII Sems.
Sun	Mon	Tue	Wed	Thu	Fri	Sat	15 th Sept. 2025	Commencement of Regular III Sem of AY: 2024-25
	1	2	3	4	5	6	15 th Sept. 2025	National Engineer's Day (NSS)
7	8	9	10	11	12	13	16 th Sept. 2025	Display of 1 st IA Test Marks of V & VII Sems.
14	15	16	17	18	19	20	26 th -27 th Sept. 2025	1 st Lab IA Test for Regular V & VII Sems. (On 02 COs/5 Expts)
21	22	23	24	25	26	27		III Sem Welcome-Function & Inauguration of Dept. Association Activities
28	29	30					30 th Sept. 2025	Academic Audit of AY:2024-25 by (Odd & Even)
1 st LH: Shri Math Mahadasoha (Tentative)							11 th Oct. 2025	
5 th GH: Ed-Milad (Teachers, Day)							16 th Sept. 2025	Display of 2 nd IA Test & CCAs Marks of Regular V & VII Sems., and 1 st IA Test Marks of Regular III Sem.
21 st GH: Mahalaya Amavasya							23 rd -25 th Oct. 2025	2 nd IA Test & CCAs of Regular V & VII Sems. (On 02 COs) and 1 st IA Test of Regular III Sem. (On 01 CO)
October -2025							25 th Oct. 2025	2 nd Feedback on T & L of V & VII Sems., and 1 st Feedback on T&L of Regular III Sem
Sun	Mon	Tue	Wed	Thu	Fri	Sat	21 st -22 nd Nov. 2025	Final Lab IA Test for Regular V & VII Sems., on remaining 03 COs/5 Expts) and 1 st Lab IA Test for Regular V & VII Sems. (On 03 COs/5 Expts)
			1	2	3	4	24 th Nov. 2025	Project Exhibition (Mini & Major) (Dept. Associations)
5	6	7	8	9	10	11	26 th Nov. 2025	Constitution Day (NSS)
12	13	14	15	16	17	18	27 th -29 th Nov. 2025	3 rd IA Test & CCAs of Regular V & VII Sems. (On 02 COs) and 2 nd IA Test & CCAs of Regular III Sem. (On 02 COs)
19	20	21	22	23	24	25	29 th Nov. 2025	2 nd Feedback on T&L of Regular III Sem
26	27	28	29	30	31		2 nd Dec. 2025	Display of 3 rd IA Test & CCAs Marks of Regular V & VII Sems. and 2 nd IA Test & CCAs Marks of Regular III Sem.
1 st -2 nd GH: Mahanavami/Ayudh Pooja, Vijay Dashami & Gandhi Jayanti on 2 nd							4 th Dec. 2025	Last Working Day of Regular V & VII Sems.
7 th GH: Maharshi Valmiki Jayanti							6 th Dec.25.-3 rd Jan. 26	VTU Theory Examinations of Regular V & VII Sem.
20 th GH: Narak Chaturdashi							9 th Dec. 2025	Anti-Corruption Day (NSS)
22 nd GH: Balipadyami, Deepavali							13 th Dec. 2025	Blood Donation Camp & Health Check-up Camp (YRC & NSS)
November -2025							26 th -27 th Dec. 2025	Indoor Sports Competitions (By Sports & Yoga Dept.)
Sun	Mon	Tue	Wed	Thu	Fri	Sat	29 th -30 th Dec. 2025	Alumni Association Activity
30						1	1 st -2 nd Jan. 2026	Final Lab IA Test for Regular III Sem., on remaining 02 COs/5 Expts)
2	3	4	5	6	7	8	4 th -10 th Jan. 2026	VTU Practical /Viva Examinations of Regular V & VII Sem.
9	10	11	12	13	14	15	5 th -7 th Jan. 2026	Tentative 3 rd IA Test & CCAs of Regular III Sem. (On 02 COs)
16	17	18	19	20	21	22	9 th Jan. 2026	Display of 3 rd IA Test & CCAs Marks of Regular III Sem.
23	24	25	26	27	28	29	12 th Jan. 2026	National Youth Day (NSS)
1 st GH: Kannada Rajyotsava							12 th Jan. 2026	Commencement of Regular VI & VIII Sems.
8 th GH: Kanakdas Jayanti							Special Note	
December -2025							As per the VTU Circular, Week End Holiday for every 1 st & 3 rd Saturday and remaining Saturdays are full working days	
Sun	Mon	Tue	Wed	Thu	Fri	Sat	T&L: Teaching & Learning Process, GH: General Holiday, LH: Local Holiday, CCA: Continuous Comprehensive Assessments, CO: Course Outcome	
	1	2	3	4	5	6	NSS: National Service Scheme, WEC: Women Empowerment Cell, YRC: Youth Red Cross	
7	8	9	10	11	12	13		
14	15	16	17	18	19	20		
21	22	23	24	25	26	27		
28	29	30	31					
25 th GH: Christmas								
January -2026								
Sun	Mon	Tue	Wed	Thu	Fri	Sat		
				1	2	3		
4	5	6	7	8	9	10		
11	12	13	14	15	16	17		
18	19	20	21	22	23	24		
25	26	27	28	29	30	31		
14 th GH: Makar Sankranti (Tentative)								
26 th GH: Republic Day (NSS)								

Dr.S.N.Topannavar
IQAC Coordinator & Dean (Academics)

Dr.S.C.Kamate
Principal

Nidasoshi, Taq. Hukkeri, Dist. Belagavi, Karnataka - 591 236
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		File I-11
		AY:2025-26 (Odd)
		Rev: 03

**COMPREHENSIVE CALENDAR OF EVENTS (CoE) FOR THE AY: 2025-26
AND CoE FOR THE SUMMER SEMESTER OF AY: 2024-25**
(Regular Odd Sems.: V & VII, w.e.f.: 4th Aug. 2025, Published on: 24th July 2025)

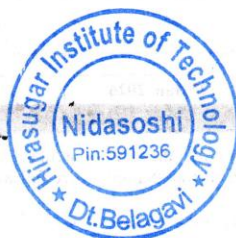
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2. VTU Summer Semester CoE Notification No.: VTU/BGM/BoS/Academic Calendar/2024-25/1657, Dated : 15th July 2025
3. VTU Holiday Notification No.: VTU/BGM/Est/CR (4)/2024-25/1580, Dated : 10th Dec. 2024

Copy to the following key authorities for:

- In-line Preparation of Curricular, Co-Curricular & Extra-Curricular Activities
- Circulation to all the staff & students
- Displaying on the Notice Boards/Web/WhatsApp Groups.

S.N.	Name & Designation	Signature
01	Dr.B.V.Madigond, HOD Electrical & Electronics Engg.	
02	Dr.K.B.Manawade, HOD Computer Science & Engg. / Dr. S.V. Manjari	
03	Dr.Mallikarjun C. Sarsamba, HOD Electronics & Communication Engg.	
04	Dr.S.N.Topannavar, HOD Mechanical Engg.	
05	Dr. M.P.Yenagimath, I Year Coordinator	
06	Prof.V.I. Patil, HOD Civil Engg.	
07	Dr.M.M.Shivasimpi, Dean (Examinations)	
08	Dr.S.N.Topannavar, Dean (Academics)	
09	Dr.K.M.Akkoli, Dean (Research & Development)	
10	Prof.S.S.Patil, NSS Officer	
11	Prof.O.B.Heddurshetti, President, Alumni Association	
12	Prof.S.S.Kamate, Coordinator-Women Empowerment Cell (WEC)	
13	Prof.P.V.Patil, Training & Placement Officer	
14	Sri. S.B.Sarwadi, Physical Education Director	
15	Sri.C.R. Ramane, Librarian	
16	Sri.S.R.Koteppagol, Office Superintendent	

Dr.S.N.Topannavar
IQAC Coordinator & Dean (Academics)



Dr.S.C.Kamate
Principal



Subject Title	MICROWAVES AND ANTENNAS		
Subject Code	BEC701	CIE Marks	50
Number of Lecture Hrs /	03+02(tutorial)	SEE Marks	50
Total Number of Lecture	40(08Hrs/Module)	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. S.S. Kamate	Designation: Asst. Professor	Experience: 22 years
No. of times course taught:01(including Present)	Specialization: M. Tech.(Digital Electronics)	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	ECE	V	Electromagnetic Waves
02	ECE	IV	Principles of Communication Systems

2.0 Course Objectives

The course objective is to make students of ECE branch of engineering to understand the fundamentals of Microwaves and Antennas for Communication Engineering Applications.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to

	Course Outcome	RBT Level	PO's
C401.1	Describe the use and advantages of microwave transmission	L1, L2, L3	1,2,3,10,12
C401.2	Analyze various parameters related to transmission lines.	L1, L2, L3	1,2,3,10,12
C401.3	Identify microwave devices for several applications	L1, L2, L3	1,2,3,10,12
C401.4	Analyze various antenna parameters and their significance in building the RF system	L1, L2, L3	1,2,3,10,12
C401.5	Identify various antenna configurations for suitable applications	L1, L2, L3	1,2,3,10,12
Total Hours of instruction		50	



4.0 Course Content

Modules	Teaching Hours	Bloom's Taxonomy (RBT) level
Module 1		
Microwave Sources: Introduction, Gunn Diode (Text2:7.1,7.1.1,7.1.2) Microwave transmission lines: Microwave frequencies, Microwave devices, Microwave systems. Transmission line equations and solutions, Reflection Coefficient and Transmission Coefficient. Standing wave and standing wave ratio .Smith chart, Single stub matching. Text 2: 0.1, 0.2, 0.3, 3.1, 3.2, 3.3, 3.5, 3.6 (except double stub matching)	08	L1, L2, L3
Module -2		
Microwave Network Theory: Introduction, S matrix representation of multi-port networks (Text1: 6.1, 6.3, 6.3.1, 6.3.2) Microwave passive devices: Coaxial connectors and Adapters, Attenuators, Phase shifters, waveguide Tees, Magic Tee, Circulator, Isolator. (Text1:6.4.2,6.4.14,6.4.15,6.4.16,6.4.17A, B)	08	L1, L2, L3
Module-3		
Strip Lines: Introduction, Microstrip lines, Parallel Striplines (Text2:11.1,11.2) Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam efficiency, Directivity and Gain, Antenna Aperture Effective height, Bandwidth, Radio communication Link, Antenna Field Zones (Text3:2.1-2.7,2.9-2.11,2.13).	08	L1, L2, L3
Module-4		
Point sources and arrays: Introduction, Point Sources, Power patterns, Power theorem, Radiation Intensity, Arrays of 2 isotropic point sources, Pattern multiplication, Linear arrays of n Isotropic sources of equal amplitude and Spacing. (Text 3: 5.1-5.6, 5.9, 5.13) Electric Dipole: Introduction, Short Electric dipole, Field s of a short dipole. Radiation resistance of a short dipole. Thin linear antenna (field analysis). (Text3: 6.1-6.5)	08	L1, L2, L3
Module-5		
Loop and Horn antenna: Introduction: Small loop, Comparison of far fields of small loops and short dipole. Radiation resistance of small loop, Horn Antennas, Rectangular antennas. (Text 3: 7.1,7.2, 7.4, 7.6, 7.7, 7.8, 7.19, 7.20) Antenna Types: Yagi Uda array, Parabolic Reflector, Microstrip Antennas, Features of Microstrip Antennas (Text3:8.8,9.5,14.1,14.2)	08	L1, L2, L3



5.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Antenna Simulation using Software's

6.0 Books Used and Recommended to Students

Text Books
1. Microwave Engineering-Annapurna Das, Sisir KDas ,TMH Publication, 2 nd Edition, 2010. 2. Microwave Devices and Circuits–Samuel YLiao, Pearson Education. Antennas and Wave Propagation- John D Krauss, Ronald J Marhefka, Ahmad S Khan,4 th Edition, McGraw Hill Education,2013
Reference Books
1. Microwave Engineering –David M Pozar ,John Wiley India Pvt Ltd, PvtL td., 3rdedition,2008. 2. Microwave Engineering- Sushrut Das, Oxford Higher Education, 2 nd Edn,2015. 3. Antennas and Wave Propagation – Harish and Sachidananda, Oxford University Press,2007

7.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) nptel.ac.in 2) <i>VTU e-learning notes</i>

8.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	Microwave Devices	www.ieee.org

9.0 Examination Note

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together. The IPCC means the practical portion integrated with the theory of the course. CIE marks for the theory component are 25 marks and that for the practical component is 25 marks.



CIE for the theory component of the IPCC

25 marks for the theory component are split into 15 marks for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and 10 marks for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for 25 marks).
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- 15 marks for the conduction of the experiment and preparation of laboratory record, and 10 marks for the test to be conducted after the completion of all the laboratory sessions.

- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

- The laboratory test (duration 02/03 hours) after completion of all the experiments shall be conducted for 50 marks and scaled down to 10 marks.

- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.

- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.

2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.

3. The students have to answer 5 full questions, selecting one full question from each module.

4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 sub questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks. @#Nov2024 IPCC (4 credits) template 5 • SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50. • The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.



10.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	Introduction,	20
	2	Gunn Diode	
	3	Gunn Diode	
	4	Microwave frequencies,	
	5	Microwave devices, Microwave systems	
	6	Transmission line equations and solutions,	
	7	Reflection Coefficient and Transmission Coefficient.	
	8	Standing wave and standing wave ratio.	
	9	Smith chart, Single stub matching	
	10	Problems	
2	11	Introduction, S matrix representation of multi-port networks (Text1: 6.1, 6.3, 6.3.1, 6.3.2)	40
	12	S matrix representation of multi-port networks (Text1: 6.1, 6.3, 6.3.1, 6.3.2)	
	13	Coaxial connectors	
	14	Adapters, Attenuators	
	15	Phase shifters	
	16	waveguide Tees	
	17	H-Plane Tee	
	18	Magic Tees	
	19	Magic Tee, Circulator, Isolator	
3	20	Strip Lines-Introduction	60
	21	Micro-strip Lines	
	22	Parallel Strip Lines	
	23	Problems	
	24	Antenna Basics	
	25	Antenna Apertures	
	26	Radio Communication Links	
	27	Antenna Zones	
	28	Numerical Problems	
4	29	Point Sources-Introduction	80
	30	Power Pattern and Power Theorem	
	31	Field Patterns and Phase Patterns	
	32	Pattern Multiplication	
	33	Linear arrays of n Isotropic sources of equal amplitude and Spacing	
	34	Short Electric dipole	
	35	Fields of a short dipole	
	36	Radiation resistance of a short dipole	
	37	Thin linear antenna	



5	39	Introduction: Small loop,	100
	40	Comparison of far fields of small loop and short dipole.	
	41	Radiation resistance of small loop	
	43	Horn Antennas	
	44	Rectangular antennas	
	45	Comparison of far fields of small loop and short dipole.	

11.0

QUESTION BANK

Module – 1

1. Explain Gunn diode.
2. Explain microwave system with neat diagram
3. List four applications of transmission line
4. Draw the elementary section of transmission line and determine the transmission line equations in general form. or
5. Derive the Voltage and Current equations for a general transmission line.
6. A transmission line has following parameters:
 $R=2\Omega/m$ $G=0.5mS/m$ $f=1GHz$ $L=8 nH/m$ $C=0.23pF$.
 Calculate a) Characteristic impedance b) Propagation constant
7. Explain Standing wave ratio of transmission line with relevant equations and sketches.
8. Explain the relation between the reflection coefficient and SWR with the curve.
9. A transmission line has a characteristic impedance of $50+j0.01\Omega$ & is terminated in a load impedance of $73-j42.5\Omega$. Calculate
 a) Reflection coefficient b) Standing Wave ratio
10. Explain the construction and working of Smith Chart.
11. Explain steps involved in finding V_{max} , V_{min} , SWR from the smith chart
12. Explain single stub matching process with the help of smith chart with necessary steps
13. Explain different methods of impedance matching for a transmission line.

Module-2

1. Explain the need of S- parameters
2. Show that impedance and admittance matrices are same for reciprocal network.
3. Explain the Scattering matrix and Scattering Parameters.
4. Explain S matrix representation of multi-port networks.
5. Explain the properties of S-Parameters
6. Two transmission lines of characteristic impedance Z_1 & Z_2 are joined at plane PP'.
Express S-parameters in terms of impedance.
7. What are Multi-Port network? Derive the 'S' matrix.
8. Explain the coaxial connectors and adapters.
9. Explain Attenuator.
10. Explain precision type variable attenuator.
11. Explain the working of phase shifters and variable phase shifters with relevant sketches.
12. Explain Magic –T and obtain its S-Matrix for both the planes
13. Explain the construction and working of Circulator and Isolator.
14. Draw the construction of E-Plane and H-Plane tee and derive the 'S' matrix for both.
 A 20mW signal is fed into one of collinear port 1 of a lossless H-plane T-junction. Calculate the power delivered through each port when other ports are terminated in matched load
15. Explain the need of S- parameters



Module-3

1. Explain the construction and field pattern of micro-strip line.
2. Derive expression for characteristic impedance of micro-strip line.
3. Explain Parallel Strip Lines with neat diagram.
4. Explain the losses in micro strip lines.
5. Explain ohmic skin losses and radiation losses in micro-strip lines.
6. Define Antenna.
7. Write a note on antenna field zones.
8. An antenna has field pattern given by $E(\theta) = \cos^2\theta$ for $0 \leq \theta \leq \pi/2$. Find the beam area and directivity.
9. Explain various terms related to antenna
a) beam width b) Radiation pattern c) directivity d) Gain & efficiency.
10. The effective apertures of transmitting & receiving antennas in a communication system are $8\lambda^2$ and $12\lambda^2$ respectively. With a separation of 1.5km between them. The EM wave travelling with frequency of 6MHz & the total input power is 25KW. Find the power received by the antenna.
11. Draw a radio link & explain various blocks.

Module -4

1. Derive an expression and draw field pattern for an array of 2 isotropic point sources with same amplitude and phase spaced $\lambda/2$ apart.
2. Show that the radiation resistance of dipole antenna is 73ohm.
3. A source has cosine intensity radiation pattern given by $U = U_m \cos\theta$ for $0 \leq \theta \leq \pi/2$ and $0 \leq \phi \leq 2\pi$. Find the total power directivity.
4. Derive an expression for the far field components of short Electric dipole.
5. Explain the principle of pattern multiplication with an example.
6. Define power theorem.
7. Obtain the field pattern for a linear uniform array of isotropic antennas, satisfy the following $n=5$, $d=\lambda/2$, $\delta = -dr$.
8. Explain Thin Linear Antenna.

Module -5

1. Write short notes on i) Yagi uda array antenna ii) parabolic reflector
2. Derive the expression for strength E_θ and H_ϕ in case of small loop.
3. Explain the working and design considerations of Helical antenna.
4. A 16 turn helical beam antenna has a circumference of λ and turn spacing $\lambda/4$. Find i) HPBW ii) axial ratio iii) directivity.
5. Obtain the expression for radiation resistance of small loop antenna
6. Compare the fields of small loop and short electric dipole
7. Draw the structure of pyramidal horn antenna.

12.0

University Result

Examination	FCD	FC	Pass	AB	% Passing
New subject	--	--	--	--	--

Prepared by	Checked by		
			
Prof. S. S. Malaj	Prof. S. S. Kamate	HOD	Principal



PRACTICAL COMPONENT OF IPCC

Sl.No	Experiments
1	Study of characteristics of Magic Tee
2	Coupling and Isolation characteristics of microstrip directional coupler.
3	Determination of power division of microstrip power divider.
4	Determination of resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate.
5	Measurement of frequency,guide wavelength ,power and attenuation in a microwave Test bench.
6	Study of characteristics of E plane Tee/H plane Tee.
7	To measure unknown impedance using Smith chart through test bench setup.
8	Measurement of VSWR and reflection coefficient and attenuation in a microwave test bench setup.
9	Obtain the radiation pattern of a Yagi-Uda Antenna array and calculate its directivity.
10	Calculate the aperture of a Dipole Antenna.
11	Obtain the near and far fields of a given antenna and compare the fields.
12	Obtain the bandwidth of a given Antenna.

Question Bank

- Q1. What are microwaves.
 Q2. What is Magic Tee.
 Q3. Explain the coupling and Isolation characteristics of Microstrip directional coupler.
 Q4. What is microstrip power divider.
 Q5. What is ring resonator. Explain the computation of dielectric constant of the substrate.
 Q6. Explain the measurement of frequency, guide wavelength ,power and attenuation in a microwave test Bench.
 Q7. Explain the study of characteristics of E plane Tee.
 Q8. Define the following: 1) VSWR 2) Reflection Coefficient
 Q9. Define the following 1) Antenna 2) Bandwidth 3) Dipole Antenna 4) Directivity
 Q10. List the types of Different Antenna.
 Q11. Define Yagi-Uda Antenna.
 Q12. Define Aperture of an antenna.
 Q13. Define bandwidth of an antenna.
 Q14. Define smith chart.

Prepared by	Checked by		
			
Prof. S. S. Malaj	Prof. S. S. Kamate	HOD	Principal



Subject Title	COMPUTER NETWORKS & PROTOCOLS		
Subject Code	BEC702	CIE Marks	50
Teaching Hours/Week (L: T: P: S)	(3:0:2:0)	SEE Marks	50
Total Number of Lecture Hrs	40	Total Marks	100
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Exam Hours	03
CREDITS – 04			
FACULTY DETAILS:			
Name: Prof. B. P. Khot	Designation: Assistant Professor	Experience: 9.7 Yrs	
No. of times course taught: 02		Specialization: Microelectronics and control systems	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electronics & Communication Engineering	III	Computer Organization & Architecture
02	Electronics & Communication Engineering	VI	Operating system

2.0 Course Objectives

1. Understand the layering architecture of OSI reference model and TCP/IP protocol suite.
2. Understand the protocols associated with each layer.
3. Learn the different networking architectures and their representations.
4. Learn the various routing techniques and the transport layer services.

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
C402.1	Understand the concepts of networking thoroughly by studying components, network types, architectures, models, and addressing	L1, L2, L3	PO1 to PO12
C402.2	Identify the protocols and services of different layers such as data link control, MAC protocols, LANs, and VLANs.	L1, L2, L3	PO1 to PO12
C402.3	Distinguish the basic network configurations and standards associated with each network through network layer operations, addressing, and routing.	L1, L2, L3	PO1 to PO12
C402.4	Discuss and analyze the various applications that can be implemented on networks using transport layer protocols like TCP and UDP.	L1, L2, L3	PO1 to PO12
C402.5	Apply standard application layer services and protocols such as HTTP, FTP, Email, DNS, and QOS to solve real-time communication and networking tasks.	L1, L2, L3	PO1 to PO12
Total Hours of instruction		40	



4.0 Course Content

Module-1	RBT Level
Introduction: Data communication: Components, Data representation, Data flow, Networks: Network criteria, Physical Structures, Network types: LAN, WAN, Switching, The Internet.. Network Models: TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP. Data-Link Layer: Introduction: Nodes and Links, Services, Two Categories' of link, Sublayers, Link Layer addressing: Types of addresses, ARP(1.1,1.2, 1.3.1to 1.3.4,2.2, 2.3 ,9.1, 9.2.1, 9.2.2)	L1, L2,L3
Module-2	
Data Link Control (DLC) services: Framing, Flow and Error Control. Media Access Control: Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. Connecting Devices: Hubs, Switches, Virtual LANs: Membership, Configuration, Communication between Switches, Advantages. Wired and Wireless LANs: Ethernet Protocol, Standard Ethernet. Introduction to wireless LAN: Architectural Comparison, Characteristics, Access Control. (11.1,12.1,13.1, 13.2.1 to 13.2.5,15.1,17.1,17.2)	L1, L2,L3
Module-3	
Network Layer: Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing, DHCP, Network Address Resolution Network Layer Protocols: Internet Protocol (IP): Datagram Format, Fragmentation, Options, Security of IPV4 Datagrams. IPV6 addressing and Protocol. Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing. (18.1(excluding 18.1.3), 18.2, 18.4,19.1,20.1, 20.2,22.1 and 22.2)	L1, L2,L3
Modul-4	
Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, GoBackN Protocol, Selective repeat protocol, Piggybacking Transport-Layer Protocols in the Internet: User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Error control, TCP congestion control. (23.1, 23.2.1, 23.2.2, 23.2.3, 23.2.4, 23.2.5,24.2, 24.3.1, 24.3.2, 24.3.3, 24.3.4, 24.3.6, 24.3.8, 24.3.9)	L1, L2, L3
Module-5	
Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client Server Protocols: Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS. Quality of Service (25.1, 26.1.2, 26.2, 26.3, 26.6, 30.1, 30.2.)	L1, L2,L3



PRACTICAL COMPONENT OF IPCC	
Using suitable simulation software, demonstrate the operation of the following :	
Sl. No	Simulation experiments using NS2/ NS3/ OPNET/ NCTUNS/ NetSim/ QualNet or any other equivalent tool
1	Implement a point to point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.
2	Implement a four node point to point network with links n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.
3	Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.
4	Implement Ethernet LAN using n nodes and assign multiple traffic to the nodes and obtain congestion window for different sources/ destinations.
5	Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.
6	Implementation of Link state routing algorithm

Implement the following using programming languages C/C++ etc.	
7	Write a program for a HDLC frame to perform the following. i) Bit stuffing ii) Character stuffing.
8	Write a program for distance vector algorithm to find suitable path for transmission
9	Implement Dijkstra's algorithm to compute the shortest routing path.
10	For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases : i) without error ii) with error
11	Implementation of Stop and Wait Protocol and Sliding Window Protocol
12	Write a program for congestion control using leaky bucket algorithm.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Project work	Computer communication network based projects.
02	VIII	Internship (Industry/Research)	Internship on Computer communication network
03	Higher study M.Tech	Computer network engineering	Wireless Ad hoc Networks, Network Programming Network Routing Algorithm

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Core Networking Knowledge– Covers protocols (TCP/IP, OSI) used in all networks.
02	Industry Tools & Simulations – Uses NCTUNS/NS2/NS3, C/C++ for practical, real-world network design.
03	Applicable in IT Careers – Relevant for jobs in networking, cloud, cyber security, and IoT.



7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Seminar/Invited talk	1. Outdated Content – Add modern topics like Cloud Networking, SDN, and virtualization. 2. Minimal Security Coverage – Include basics like VPNs, firewalls, and DNS security.

8.0 Books Used and Recommended to Students

Text Books
1. Forouzan, “Data Communications and Networking” , 5th Edition, McGraw Hill, 2013, ISBN: 1-25-906475-3.
Reference Books
1. A.S Tanenbaum - Computer Networks, 4th Edition, PHI, 2003
2. Computer Networks, James J Kurose, Keith W Ross, Pearson Education, 2013, ISBN: 0-273-76896-4
3. Introduction to Data Communication and Networking, Wayarles Tomasi, Pearson Education, 2007, ISBN: 0130138282

9.0 Relevant Websites (Reputed Universities and Others) for Notes /Animation / Videos Recommended

Website and Internet Contents References
1. NOC: Computer Networks and Internet Protocol, IIT Kharagpur by Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty https://nptel.ac.in/courses/106105183
2. Data Link Layer - Flow and Error Control https://youtu.be/TrgZ7_L525w
3. IP Routing https://youtu.be/IfzGf4kI2a8
4. Data Link Layer – Ethernet https://youtu.be/WXiGbQa-5F4 Computer Networking: Principles, Protocols and Practice: This is an online textbook and resource that covers computer networking principles and practices. (Website: http://www.computer-networks.org/)
5. NetworkLessons.com: This website offers a collection of networking lessons, articles, and tutorials on various networking topics. (Website: https://networklessons.com/)

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	IEEE	IEEE Open Journal of the Communications Society - This open-access journal covers a wide range of topics in communication systems and networks. (Website: https://ieeaccess.ieee.org/communications/) IEEE Open Journal of the Computer Society - This open-access journal focuses on computer science topics, including computer networks and communications. (Website: https://ieeaccess.ieee.org/computer-science/)

11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.



CIE for the theory component of IPCC

Two Tests each of 20 Marks (duration 01 hour)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for 30 marks.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The 15 marks are for conducting the experiment and preparation of the laboratory record, the other 05 marks shall be for the test conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test (duration 03 hours) at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 20 marks.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.

The students have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
Module- 1 Introduction & Network Models	1	Data communication: Components, Data representation, Data flow	20
	2	Networks: Network criteria, Physical Structures	
	3	Network types: LAN, WAN, Switching, The Internet.	
	4	Network Models: TCP/IP Protocol Suite: Layered Architecture,	
	5	Layers in TCP/IP suite Description of layers, Encapsulation and Decapsulation,	
	6	Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP.	
	7	Data-Link Layer: Introduction: Nodes and Links, Services, Two Categories' of link, Sublayers,	
	8	Link Layer addressing: Types of addresses, ARP	



Module- 2 Data-Link Layer	9	Data Link Control (DLC) services Framing, Flow and Error Control,	20
	10	Media Access Control	
	11	Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA	
	12	Connecting Devices: Hubs, Switches	
	13	Virtual LANs: Membership, Configuration, Communication between Switch	
	14	Wired and Wireless LANs: Ethernet Protocol, Standard Ethernet.	
	15	Introduction to wireless LAN: Architectural Comparison,	
	16	Characteristics, Access Control	
Module -3 Network Layer	17	Introduction, Network Layer services: Packetizing,	20
	18	Routing and Forwarding, Other services, Packet Switching: Datagram Approach,	
	19	Virtual Circuit Approach, IPV4 Addresses: Address Space,	
	20	Classful Addressing, Classless Addressing, DHCP,	
	21	Network Address Resolution Network Layer Protocols: Internet Protocol (IP):	
	22	Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams.	
	23	IPv6 addressing and Protocol. Unicast Routing: Introduction,	
	24	Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing.	
Module -4 Transport Layer	25	Transport Layer: Introduction to Transport Layer Services	20
	26	Connectionless and Connection oriented Protocols	
	27	Transport Layer Protocols: Simple protocol, Stop and wait protocol	
	28	Go-Back N Protocol, Selective repeat protocol. , Piggybacking Transport-Layer Protocols in the Internet	
	29	User Datagram Protocol: User Datagram, UDP Services, UDP Applications	
	30	Transmission Control Protocol: TCP Services	
	31	TCP Features, Segment, Connection, State Transition diagram	
	32	Windows in TCP, Flow control, Error control, TCP congestion control.	
Module 5: Application Layer	33	Introduction: providing services, Application- layer paradigms	20
	34	Standard Client –Server Protocols, Hyper Text Transfer Protocol	
	35	FTP: Two connections, Control Connection,	
	36	Data Connection, Electronic Mail: Architecture	
	37	Domain Name system: Name space,	
	38	DNS in internet, Resolution,	
	39	DNS Messages, Registrars,	
	40	DDNS, security of DNS, Quality of Service	



13.0

QUESTION BANK

Module 1: Introduction & Network Models

1. Explain the components of a data communication system with a neat diagram.
2. Compare OSI and TCP/IP models in detail with a layered architecture diagram.
3. Describe different types of data flow and network criteria in data communication.
4. Discuss LAN, WAN, and Switching techniques with examples and applications.
5. Explain protocol layering principles with scenarios and logical connections.
6. Describe the concept of encapsulation and decapsulation with suitable examples.
7. Explain different types of addressing schemes used in TCP/IP.
8. Write a detailed note on Multiplexing and Demultiplexing in networking.
9. Illustrate the structure and services of the Data Link Layer.
10. Define ARP. Explain its working and message format with reference to link-layer addressing.

Module 2: Data-link Layer

1. Explain framing techniques and flow control mechanisms in Data Link Control.
2. Compare and contrast ALOHA, CSMA, CSMA/CD, and CSMA/CA protocols.
3. Describe the working of switches and hubs with their advantages.
4. Explain the architecture and operation of a Virtual LAN with its configurations.
5. Define and explain the characteristics of wired Ethernet and its frame structure.
6. Write a detailed note on Standard Ethernet with speed and format details.
7. Compare wired and wireless LANs based on architecture and access methods.
8. Describe the MAC sublayer responsibilities and how it handles collisions.
9. Explain access control methods in wireless LANs with diagrams.
10. Discuss the communication between switches in VLAN and the concept of trunking.

Module 3: Network Layer

1. Explain the functions of the Network Layer and the concept of packet switching.
2. Differentiate between Datagram and Virtual Circuit packet switching with examples.
3. Describe Classful and Classless addressing in IPv4 with examples.
4. Explain the structure of IPv4 datagram with a labeled diagram.
5. What is fragmentation in IPv4? Explain with an example and diagram.
6. Discuss the functioning of DHCP and how it assigns IP addresses dynamically.
7. Write a note on IPv6 addressing format and differences from IPv4.
8. Explain Distance Vector and Link State Routing algorithms with examples.
9. Describe the format and working of the Internet Protocol (IP).
10. Explain the purpose and working of Path Vector Routing in internetworks.

Module 4: Transport Layer

1. Compare Connection-Oriented and Connectionless services at the Transport Layer.
2. Explain the working of Stop-and-Wait and Go-Back-N ARQ protocols.
3. Describe the Selective Repeat protocol and its advantages over Go-Back-N.
4. Illustrate and explain the piggybacking technique in reliable transmission.
5. Compare UDP and TCP in terms of services, applications, and reliability.
6. Explain the TCP segment structure and its key fields with a diagram.
7. Write a note on TCP's three-way handshake connection establishment.
8. Describe the TCP State Transition Diagram in detail.
9. Explain TCP window management and flow control using sliding windows.
10. Discuss TCP congestion control techniques in detail.

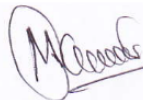


Module 5: Application Layer

1. Explain the client-server paradigm and peer-to-peer model with examples.
2. Describe the working of HTTP protocol with request and response message formats.
3. Explain the architecture of FTP and the role of control and data connections.
4. Discuss the structure and operation of email protocols and their architecture.
5. Explain the hierarchical structure of DNS and types of records.
6. Describe the process of domain name resolution and the types of queries in DNS.
7. What is Dynamic DNS (DDNS)? How does it differ from static DNS?
8. Explain DNS message format and security features implemented in DNS.
9. Discuss the role and importance of Quality of Service (QoS) in networking.
10. Describe various application-layer services and their importance in end-to-end communication.

13.0 University Result

Examination	FCD	FC	SC	% Passing
2023-24	20	09	16	97.82
2022-23	15	7	7	100
2021-22	0	33	1	100

Prepared by	Checked by		
			
Prof. B. P. Khot	Dr. S. S. Ittannavar	HOD	Principal



Subject Title	Wireless Communication Systems		
Subject Code	BEC703	CIE	50
Number of Lecture Hrs/Week /	04(L)	SEE	50 (100)
Total Number of Lecture Hrs	50 hours	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:

Name: Dr. S. S. Ittannavar	Designation: Associate Professor	Experience: 13 years
No. of times course taught: 01	Specialization: Digital Signal Processing	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	1, 4	Basic Electronics, Digital Communication

2.0 Course Objectives

This course will enable students to:

- Understand the concepts of signal propagation over wireless channels
- Understand the multiple access techniques used in cellular communications standards.
- Understand the system architecture and layers of LTE based on the use of OFDMA and SCFDMA principles.
- Understand the design and coding of MIMO wireless systems.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to

	Course Outcome	Cognitive Level	PO's
CO1	Describe the wireless channel models for slow and fast fading environment.	U	1,2,3,4,6,7,9,10,11,12
CO2	Explain the fundamental principles of CDMA and OFDM, including spreading codes, correlation properties, and multicarrier transmission techniques, and analyze their advantages and applications in modern wireless communication systems.	U	1,2,3,4,5,6,7,9,10,11,12
CO3	Describe the evolution of cellular technologies from 1G to LTE, including network architecture and key enabling technologies, and analyze frequency domain multiple access techniques such as OFDMA and SC-FDMA used in modern wireless communication systems.	U	1,2,3,4,5,6,7,9,10,11,12
CO4	Describe the of MIMO transmitter and receiver process using coding examples.	U	1,2,3,4,5,6,7,9,10,11,12
CO5	Understand the system architecture and the functional standard specified in LTE 4G.	U	1,2,3,4,5,6,7,9,10,11,12
Total Hours of instruction		50	



4.0 Course Content

Modules	Teaching Hours	Bloom's Taxonomy (RBT) level
Module 1		
Principles of Wireless Communications: The Wireless Communication Environment, Modelling of wireless systems, System model for narrowband Signals, Rayleigh fading Wireless Channel. The Wireless Channel: Basics of Wireless Channel Modelling, Average Delay Spread in Outdoor Cellular Channels, Coherence bandwidth, Relation between ISI and Coherence Bandwidth, Doppler fading, Doppler Impact on a wireless Channel, Coherence Time. [Text1: 3.1 to 3.4, 4.1 to 4.7].	10	L1, L2,L3
Module -2		
Code Division for Multiple Access (CDMA): Basic CDMA Mechanism, Fundamentals of CDMA codes, Spreading Codes based on PN sequences, Correlation Properties of Random CDMA Spreading Sequences, Advantages of CDMA. Orthogonal Frequency Division Multiplexing (OFDM): Introduction, Motivation and Multicarrier basics, OFDM basics, OFDM Example, MIMO OFDM, OFDM Peak to Average Power ratio, SC-FDMA. [Text1: 5.1 to 5.5, 5.7, 7.1, 7.2, 7.3, 7.5, 7.7, 7.8].	10	L1, L2,L3
Module-3		
Evolution of Cellular Technologies: First Generation Cellular Systems, 2G Digital cellular systems – GSM and its Evolution, 3G Broadband Wireless Systems, Key Enabling Technologies and features of LTE, LTE Network Architecture. Frequency Domain Multiple Accesses: Multiple Access for OFDM Systems, Orthogonal Frequency Division Multiple Access, Single Carrier Frequency Division Multiple Access. [Text2: 1.2.1, 1.2.1.1, 1.2.2, 1.2.2.1, 1.2.3 (Only the mentioned sections and subsections), 1.4, 1.5, 4.1, 4.2, 4.3].	10	L1, L2,L3
Module-4		
Multiple Input Multiple Output Wireless Communications: Introduction to MIMO Communications, MIMO system Model, MIMO Zero Forcing Receiver, MIMO MMSE Receiver, Singular Value decomposition of MIMO Channel, SVD and MIMO capacity, Alamouti and Space-Time Codes, Nonlinear MIMO receiver: V-Blast, MIMO Beamforming. [Text1:6.1,6.2, 6.3, 6.4, 6.5, 6.6, 6.8, 6.9, 6.10].	10	L1, L2,L3
Module-5		
Overview and Channel Structure of LTE: Radio Interface Architecture, LTE Design principles, Network Architecture, Radio Interface Protocols, Hierarchical Structure of LTE: Logical Channels, transport Channels and Physical Channels, Channel mapping, Downlink OFDMA Radio resources, Physical Resource Blocks for OFDMA, Uplink SC-FDMA Radio resources. [Text2: 6.1 to 6.4].	10	L1, L2, L3



5.0 Relevance to future subjects

Sl. No	Semester	Subject	Topics
01	VII / VIII	Project work	Wireless communication

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Enables understanding and optimization of modern wireless communication systems such as 4G LTE and 5G networks used globally.
02	Facilitates the design and analysis of efficient multiple access and MIMO techniques for high-speed mobile data services.
03	Provides insights into practical wireless channel behaviour, improving real-world applications like IoT, autonomous vehicles, and smart city connectivity.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL	Advanced 3G and 4G wireless Mobile Communications: https://nptel.ac.in/courses/117104099

8.0 Books Used and Recommended to Students

Text Books
1. Aditya K Jagannatham, “Principles of Modern Wireless Communication systems, Theory and Practice”, Mc Graw Hill Education (India) Private Limited, 2017, ISBN 978-81- 265-4231-4. 2. Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed, “Fundamentals of LTE”, Pearson India Education Services Private Limited, 2018, ISBN: 978-93-530-6239-2.
Reference Books
1. T L Singal, “Wireless Communications”, Mc Graw Hill Education (India) Private Limited, 2016, ISBN:978-0- 07-068178-1 2. Theodore Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 2002, ISBN 0-13-042232-0. 3. Gary Mullet, Introduction to Wireless Telecommunications Systems and Networks, First Edition, Cengage Learning India Pvt Ltd., 2006, ISBN - 13: 978-81-315-0559-5.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
01) https://ocw.mit.edu , It consists of High-quality lecture notes, video lectures, and animations on wireless channel modeling, OFDM, MIMO, etc. 02) https://web.stanford.edu/class/ee359/ , It consists of OFDM, MIMO, and LTE fundamentals. 03) https://nptel.ac.in/courses/108/104/108104098/ Excellent Indian context, animations, and real-world applications explained by IIT professors.



10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Communications Magazine	https://www.comsoc.org/publications/magazines/ieee-communications-magazine
2	IEEE Wireless Communications Magazine	https://www.comsoc.org/publications/magazines/ieee-wireless-communications
3	IEEE Transactions on Wireless Communications	https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7693

11.0 Examination Note

Assessment Details (both CIE and SEE): The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course **(duration 03 hours)**.

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.



12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	Teaching Method	% of Portion
1.	1	Principles of Wireless Communications: The Wireless Communication Environment	Chalk and talk	20
	2	Modelling of wireless systems, System model for narrowband Signals	Chalk and talk	
	3	Rayleigh fading Wireless Channel.	Chalk and talk	
	4	The Wireless Channel: Basics of Wireless Channel Modelling	Chalk and talk	
	5	Average Delay Spread in Outdoor Cellular Channels	Chalk and talk	
	6	Coherence bandwidth	Chalk and talk	
	7	Relation between ISI and Coherence Bandwidth	Chalk and talk	
	8	Doppler fading	Chalk and talk	
	9	Doppler Impact on a wireless Channel, Coherence Time.	Chalk and talk	
	10	Problems	Chalk and talk	
2.	11	Code Division for Multiple Access (CDMA): Basic CDMA Mechanism	Chalk and talk	20
	12	Fundamentals of CDMA codes	Chalk and talk	
	13	Spreading Codes based on PN sequences	Chalk and talk	
	14	Correlation Properties of Random CDMA Spreading Sequences	Chalk and talk	
	15	Advantages of CDMA. Orthogonal Frequency Division Multiplexing (OFDM): Introduction	Chalk and talk	
	16	Motivation and Multicarrier basics	Chalk and talk	
	17	OFDM basics, OFDM Example	Chalk and talk	
	18	MIMO OFDM	Chalk and talk	
	19	OFDM Peak to Average Power ratio	Chalk and talk	
	20	SC-FDMA.	Chalk and talk	
3.	21	Evolution of Cellular Technologies: First Generation Cellular Systems	Chalk and talk	20
	22	2G Digital cellular systems	Chalk and talk	
	23	GSM and its Evolution	Chalk and talk	
	24	3G Broadband Wireless Systems	Chalk and talk	
	25	Key Enabling Technologies	Chalk and talk	
	26	Features of LTE	Chalk and talk	
	27	LTE Network Architecture.	Chalk and talk	
	28	Frequency Domain Multiple Accesses: Multiple Access for OFDM Systems	Chalk and talk	
	29	Orthogonal Frequency Division Multiple Access	Chalk and talk	
	30	Single Carrier Frequency Division Multiple Access.	Chalk and talk	



4.	31	Multiple Input Multiple Output Wireless Communications: Introduction to MIMO	Chalk and talk	20
	32	MIMO system Model	Chalk and talk	
	33	MIMO Zero Forcing Receiver	Chalk and talk	
	34	MIMO MMSE Receiver	Chalk and talk	
	35	Singular Value decomposition of MIMO Channel	Chalk and talk	
	36	SVD and MIMO capacity,	Chalk and talk	
	37	Alamouti and Space-Time Codes,	Chalk and talk	
	38	Nonlinear MIMO receiver: V-Blast	Chalk and talk	
	39	MIMO Beamforming.	Chalk and talk	
	40	Problems	Chalk and talk	
5.	41	Overview and Channel Structure of LTE: Radio Interface Architecture	Chalk and talk	20
	42	LTE Design principles	Chalk and talk	
	43	Network Architecture	Chalk and talk	
	44	Radio Interface Protocols	Chalk and talk	
	45	Hierarchical Structure of LTE: Logical Channels	Chalk and talk	
	46	Transport Channels and Physical Channels	Chalk and talk	
	47	Channel mapping	Chalk and talk	
	48	Downlink OFDMA Radio resources	Chalk and talk	
	49	Physical Resource Blocks for OFDMA	Chalk and talk	
	50	Uplink SC-FDMA Radio resources.	Chalk and talk	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1	Students study the Topics and will prepare for Final Exam.	Module-1, 2 & 3 of the syllabus	9	Individual Activity	Text Book 1& Text Book 2
2	Assignment 2	Students study the Topics and will prepare for Final Exam.	Module-4 & 5 of the syllabus	12	Individual Activity.	Text Book 1& Text Book 2



14.0 University Result

Examination	S+	S	A	B	C	D	E	F	% of passing
First Time Introduced	-	-	-	-	-	-	-	-	-

15.0 SAMPLE QUESTION BANK

Module-1:

1. Explain the wireless communication environment with a neat diagram.
2. Derive the system model for narrowband signals in wireless communication.
3. Discuss the Rayleigh fading channel and its characteristics.
4. Explain the relation between ISI and Coherence Bandwidth with an example.
5. Describe the impact of Doppler fading on wireless channels and coherence time calculation.

Module-2: CDMA & OFDM

1. Explain the basic CDMA mechanism with spreading code examples.
2. Discuss PN-sequence-based spreading codes and their correlation properties.
3. With a neat diagram, explain the OFDM system basics and working principle.
4. Write short notes on MIMO OFDM and Peak-to-Average Power Ratio (PAPR) problem in OFDM.
5. Explain the advantages of SC-FDMA over OFDM.

Module-3: Evolution of Cellular Technologies & Frequency Domain Multiple Access

1. Compare the features of 1G, 2G, 3G, and LTE systems in a tabular form.
2. Explain the LTE Network Architecture with a block diagram.
3. Discuss Key enabling technologies of LTE and their features.
4. Explain Orthogonal Frequency Division Multiple Access (OFDMA) and its application in LTE.
5. Describe the working of Single Carrier Frequency Division Multiple Access (SC-FDMA) with a neat diagram.

Module-4: MIMO Wireless Communications

1. Explain the MIMO system model and capacity analysis using SVD.
2. Derive the working of Zero Forcing (ZF) and MMSE receivers in MIMO systems.
3. Describe the Alamouti Space-Time Block Code with suitable diagrams.
4. Explain the principle of V-BLAST architecture with advantages.
5. Discuss MIMO Beamforming techniques and their benefits in LTE.

Module-5: LTE Channel Structure

1. Explain the Radio Interface Architecture and Design Principles of LTE.
2. Describe the Logical, Transport, and Physical channels in LTE with a neat diagram.
3. Discuss the channel mapping and physical resource blocks for OFDMA in LTE downlink.
4. Explain the uplink SC-FDMA radio resources and advantages in LTE.
5. With a neat diagram, describe the hierarchical structure of LTE channels.

Prepared by	Checked by		
			
Dr. S. S. Ittannavar	Prof. D. M. Kumbhar	HOD	Principal



Subject Title	AUTOMATIVE ELECTRONICS		
Subject Code	BEC714C	CIE Marks	50
Number of Lecture Hrs / Week	03	SEE Marks	50
Total Number of Lecture Hrs	40 (08 Hours per Module)	Exam Hours	03

FACULTY DETAILS:			
Name: Prof. S. M. Patil	Designation: Assistant Professor	Experience: 2 year	
No. of times course taught: 01	Specialization: VLSI and Embedded System		

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	ECE	IV	UNIVERSAL HUMAN VALUES
02	ECE	VI	CONSUMER ELECTRONICS

2.0 Course Objectives

This course will enable students to:

- Understand the basics of automobile dynamics and design electronics to complement those features.
- Design and implement the electronics that attribute the reliability, safety and smartness to the automobiles providing add on comforts.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to draw and analyze.

	Course Outcome	RBT Level	POs
C406A.1	Describe the basics of Automobile dynamics and design electronics.	L1, L2	PO1,2,3,4,5,6,12
C406A.2	Acquire an overview of automotive components, subsystems and basics of Electronics Engine control in today's automotive industry,	L1, L2	PO1,2,3,4,5,6,12
C406A.3	Use available automotive sensors and actuators while interfacing with microcontrollers/microprocessors during automotive system design.	L1, L2	PO1,2,3,4,5,6,12
C406A.4	Understand the networking of various modules in automotive systems, Communication protocols and diagnostics of the sub systems.	L1, L2	PO1,2,3,4,5,6,12
C406A.5	Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts and get fair idea on	L1, L2, L3	PO1,2,3,4,5,6,12
Total Hours of instruction			40



4.0 Course Content

Module 1	RBT Level
Automotive Fundamentals Overview – Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System (Text 1: Chapter1), Starter Battery –Operating principle: (Text 2: Pg. 407-410) (4 hours) The Basics of Electronic Engine Control – Motivation for Electronic Engine Control – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel controlsystem, Analysis of intake manifold pressure, Electronic Ignition. (Text 1: Chapter 5) (4 hours)	L1, L2
Module 2	
Automotive Control System applications of Sensors and Actuators – Typical Electronic Engine Control System, Variables to be measured (Text 1: Chapter 6) (1 hour) Automotive Sensors – Airflow rate sensor, Strain Gauge MAP sensor, Hall effect Position Sensor, Magnetic Reluctance Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O₂/EGO) Lambda Sensors, Piezoelectric Knock Sensor. (Text 1: Chapter 6) (5 hours) Automotive Actuators – Solenoid, Fuel Injector, EGR Actuator, Ignition System (Text 1: Chapter 6) (2 hours)	L1, L2
Module 3	
Digital Engine Control Systems – Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System - Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics. (Text 1: Chapter 7) (6 hours) Control Units – Operating conditions, Design, Data processing, Programming, Digital modules in the Control unit, Control unit software. (Text 2: Pg. 196-207) (2 hours)	L1, L2
Module 4	
Automotive Networking –Bus Systems – Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles (Text 2: Pg. 85-91), Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. (Text 2: Pg. 92-151) (6 hours) Vehicle Motion Control – Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS) (Text 1: Chapter 8) (2 hours)	L1, L2
Module 5	
Automotive Diagnostics –Timing Light, Engine Analyzer, On-board diagnostics, Off- board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems. (Text 1: Chapter 10) (2 hours) Future Automotive Electronic Systems – Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation – Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control (Text 1: Chapter 11) (6 hours)	L1, L2, L3



5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Embedded System
02	V/VI	Mini Project	Embedded System
03	VIII	Project work	Automobile System

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Understand the basics of automobile dynamics and design electronics to complement those features.
02	Design and implement the electronics that attribute the reliability, safety and smartness to the automobiles providing add on comforts.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Understand the basics of automobile dynamics and design electronics to complement those features.

8.0 Books Used and Recommended to Students

Text Books
1. William B. Ribbens, —Understanding I, 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
Reference Books
NIL
Additional Study material & e-Books
1. NPTEL notes and Videos https://onlinecourses.nptel.ac.in/noc20_de06/preview
2. VTU Online notes.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
04) https://nptel.co.in

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	IEEE Explorer	http://ieee.com
2	International Journal of Science and Technology	http://www.sciencedirect.com/science/journal/00207683
3	Journal of Communication Engineering	http://ieee.com



11.0 Examination Note

Continuous Internal Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component. • Each test shall be conducted for 25 marks.

The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus.

The average of the two tests shall be scaled down to 25 marks

- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The schedule for assignments shall be planned properly by the course teacher.

The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)

- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks. Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

12.0 Course Delivery Plan

Course Delivery Plan:

Module	Lecture No.	Content of Lecture	% of Portion
1	1	Evolution of Automotive Electronics.	20
	2	Automobile Physical Configuration, Survey of Major Automotive Systems.	
	3	The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery – Operating principle	
	4	Engine Control, Ignition System - Spark plug.	
	5	High voltage circuit and distribution, Spark pulse generation.	
	6	Ignition Timing, Diesel Engine, Drive Train – Transmission.	
	7	Drive Shaft, Differential, Suspension, Brakes.	
	8	Steering System, Starter Battery – Operating principle.	



2	9	Automotive Control System applications of Sensors and Actuators.	40
	10	Typical Electronic Engine Control System, Variables to be measured.	
	11	Automotive Sensors – Airflow rate sensor, Strain Gauge MAP sensor,	
	12	Magnetic Reluctance Position Sensor,	
	13	Hall effect position sensor	
	14	Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor.	
	15	Exhaust Gas Oxygen (O2/EGO) Lambda Sensors, Piezoelectric Knock Sensor.	
	16	Automotive Actuators – Solenoid, Fuel Injector, EGR Actuator, Ignition s System.	
3	17	Digital Engine Control Systems – Digital Engine control features, Control modes for fuel Control (Seven Modes).	60
	18	EGR Control, Electronic Ignition Control - Closed loop Ignition timing, Spark Advance Correction Scheme.	
	19	Integrated Engine Control System - Secondary Air Management.	
	20	Evaporative Emissions Canister Purge, Automatic System Adjustment.	
	21	System Diagnostics, Control Units – Operating conditions.	
	22	Design, Data processing.	
	23	Programming, Digital modules in the Control unit.	
	24	Control unit software.	
4	25	Automotive Networking –Bus Systems.	80
	26	Classification, Applications in the vehicle, Coupling of networks.	
	27	Examples of networked vehicles, Buses - CAN Bus.	
	28	LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.	
	29	Vehicle Motion Control – Typical Cruise Control System.	
	30	Digital Cruise Control System, Digital Speed Sensor,	
	31	Throttle Actuator, Digital Cruise Control configuration,	
	32	Cruise Control Electronics (Digital only), Antilock Brake System (ABS).	
5	33	Automotive Diagnostics –Timing Light, Engine Analyzer.	100
	34	On-board diagnostics, Off- boarddiagnostics,ExpertSystems.	
	35	OccupantProtectionSystems–Accelerometerbased Air Bag systems.	
	36	Future Automotive Electronic Systems – Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars.	
	37	Collision, Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis.	
	38	Navigation– NavigationSensors-RadioNavigation, Signpostnavigation,.	
	39	dead reckoning navigation, Voice Recognition Cell Phone dialing, AdvancedCruiseControl.	
	40	StabilityAugmentation, Automatic driving Control.	



13.0 QUESTION BANK

Module 1:

1. Briefly explain the four stroke cycle of an IC engine with neat diagrams.
2. Explain the working of disk break system with neat diagram.
3. Explain the working electronic ignition control with neat diagram.
4. Explain the effect of air/fuel ratio on performance.
5. Explain the neat diagram of spark plug.
6. Explain operating principle of starter battery.
7. Briefly explain the steering system.
8. Explain the concept of electronic engine control system.
9. Explain the analysis of intake manifold pressure.
10. Define power, BSFC, torque & volumetric efficiency.

Module 2:

1. Explain the working of the MAF sensor with neat diagram.
2. Explain the working of EGO sensor with neat diagram.
3. Explain the working of magnetic reluctance position sensor with relevant diagram.
4. Explain the working of fuel injector and pulse mode fuel control signal with diagrams & waveforms.
5. Explain optical crankshaft position sensor.
6. Explain EGR actuator control with relevant system.
7. Explain engine coolant temperature sensor.
8. Explain solenoid fuel injector.
9. Explain exhaust gas oxygen lambda sensor.
10. Explain piezoelectric knock sensor.

Module 3:

1. What are the seven modes of fuel control? Explain engine warm-up with relevant equations.
2. Explain the working of idle air control with relevant diagrams.
3. Explain the closed loop ignition timing with relevant diagrams.
4. What are the various modules of control unit software? Explain them briefly.
5. With neat block diagram, explain EGR control.
6. Explain integrated engine control system.
7. Explain control unit software.
8. Explain spark advance correction scheme.
9. Explain data processing of control units.
10. Explain the digital modules in the control unit.

Module 4:

1. Explain the cruise control system with relevant diagram.
2. Explain anti braking system with relevant system.
3. With relevant diagram, write note on digital speed sensor.
4. Write a note on system diagnosis.
5. Briefly explain i) LIM BUS ii) MOST BUS.
6. Explain flex ray & diagnostic interfaces.
7. Explain the coupling of networks.
8. Explain CAN protocol layers.
9. Explain throttle sensor.
10. Explain the examples of networked vehicles.

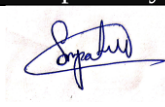
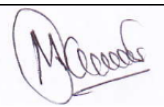
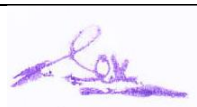


Module 5:

1. Write brief note on on-board and off-board diagnostics.
2. Explain accelerometers based airbag system.
3. Explain collision avoidance radar warning system with neat diagram.
4. Explain the automatic driving control system with relevant system.
5. Write note on deadlock reckoning navigation.
6. Explain timing light & engine analyzer.
7. Explain advanced cruise control.
8. Explain occupant protection system.
9. Explain low tire pressure warning system.
10. Explain voice recognition cell phone dialing.

14.0 University Result

Examination	No. of students appeared	No. of students passed	% Passing
Dec-2018/Jan-2019	20	20	100

Prepared by	Checked by		
			
Prof. S. M. Patil	Dr. M. C. Srasamba	HOD	Principal



Subject Title	ENERGY CONSERVATION AND AUDIT		
Subject Code	BEE755B	CIE Marks	50
Teaching	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:

Name: Prof. S. J. Patil	Designation: Asst. Professor	Experience: 12Years
No. of times course taught(including present):01		Specialization: Industrial Electronics

1.0 Prerequisite Subjects:

Sl. No	Basics required	Class	Subject
01	Basic knowledge of electrical Energy calculation and Electricity billing	I/II	EEE
02	Basic Knowledge of Economic and Electricity Tariff calculation	IV	EPG
03	Performance parameters of electrical Machines	IV	EM

2.0 Course Objectives

- Understand the current energy scenario and importance of energy conservation.
- Understand the methods of improving energy efficiency in different electrical systems.
- Realize energy auditing.
- Explain about various pillars of electricity market design.
- To explain the scope of demand side management, its concept and implementation issues and strategies.

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
C409.1	Analyze about energy scenario nationwide and worldwide, also outline Energy Conservation Act and it features.	L1 L2 L3	1, 2, 3, 4, 6, 7, 8, 10, 11,12
C409.2	Discuss load management techniques and energy efficiency.	L1 L2 L3	1, 2, 3, 4, 6, 7, 8,10, 11, 12
C409.3	Understand the need of energy audit and energy audit methodology.	L1 L2 L3	1, 2, 3, 4, 6, 7, 8,10, 11, 12
C409.4	Understand various pillars of electricity market design and Conduct energy audit of electrical systems and buildings	L1 L2 L3	1, 2, 3, 4, 6, 7, 8,10, 11, 12
C409.5	Show an understanding of demand side management and energy conservation.	L1 L2 L3	1, 2, 3, 4, 6, 7, 8,10, 11, 12
Total Hours of instruction		40	



4.0 Course Content

MODULE-1

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features

MODULE-2

Energy Efficiency in Electrical Systems: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Electronic ballast, Energy efficient lighting and measures of energy efficiency in lighting system

MODULE-3

Energy auditing: Introduction, Elements of energy audits, different types of audit, energy use profiles, measurements in energy audits, presentation of energy audit results.

MODULE-4

Electricity vis-à-vis Other Commodities: Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Framework of Indian power sector and introduction to the availability based tariff (ABT).

MODULE-5

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

Demand side Management: Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM

5.0 Relevance to Real World

SL.No	Real World Mapping
1.	Understanding the Energy Scenario and Energy conservation Act-2001 and its features
2.	Understand the Energy efficiency in Electrical systems.
3.	Understand the Energy Audit applied to building and Demand side Management



6.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
1	Demonstration (Using Models, Charts and field visits)	Topic: 1) Field visit of HT Substation, Power distribution control panel room and Generator to understand electricity billing and layout. 2) Field visit to Solar and Wind power plant to study the Energy conservation and Audit.

7.0 Books Used and Recommended to Students

Text Books:

1. Energy Management Handbook, W.C. Turner, John Wiley, and Sons.
2. Energy Efficient Electric Motors and Applications, H.E. Jordan Plenum Pub Corp.
3. Energy Management W. R. Murphy, G. Mckay Butterworths

Reference Books:

1. Energy Science Principles, Technologies and Impact, J. Andrews, N. Jelley Oxford University Press.
2. Market operations in power systems: Forecasting, Scheduling, and Risk Management, Shahedepour M., Yamin H., Zuyi Li, John Wiley & Sons, New York.
3. Energy Conservation, Diwan, P, Pentagon Press, (2008)..

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References

- 3) <http://nptel.vtu.ac.in/econtent/BS.php>
- 4) <https://www.electrical4u.com>

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Journal of Electrical Engg.	http://www.jee.ro
2	Electrical4U	http://www.electrical4u.com



10.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation(CIE):

Three Tests each of 25 Marks;

- 1st, 2nd, and 3rd tests shall be conducted after completion of the syllabus of 30-35%, 70-75%, and 90-100% of the course/s respectively.
- The average of best two IAs will be considered for the CIE.
- If the nature of the courses requires assignments/Seminars/Quizzes/group discussion, etc, **TWO** evaluation components shall be conducted for 25 Marks each and average of this will be considered for CIE.

Total CIE marks will be 50 marks (IA + CCE)

Semester End Examination (SEE):

Only those students who satisfy the attendance and CIE requirement shall be eligible to appear for the SEE of that course.

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper shall be set for 100 marks. The medium of the question paper shall be English/Kannada). The duration of SEE is 03 hours.
- The question paper will have 10 questions. Two questions per module. Each question is set for 20marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.



11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecture	% of Portion coverage
I	1.	Commercial and Non-commercial energy, primary energy resources	20
	2.	Commercial energy production, final energy consumption	
	3.	Energy needs of growing economy, long term energy scenario	
	4.	Energy pricing, energy sector reforms, energy and environment	
	5.	Energy security, energy conservation and its importance	
	6.	Restructuring of the energy supply sector, energy strategy for the future	
	7.	Air pollution, climate change	
	8.	Energy Conservation Act-2001 and its features	
II	9.	Electricity billing, Electrical load management and maximum demand Control	20
	10.	Maximum demand controllers; Power factor improvement	
	11.	Automatic power factor controllers, efficient operation of transformers	
	12.	Energy efficient motors, Soft starters, Variable speed drives	
	13.	Performance evaluation of fans and pumps	
	14.	Flow control strategies and energy conservation	
	15.	Opportunities in fans and pumps, Electronic ballast	
	16.	Energy efficient lighting and measures of energy efficiency in lighting system.	
III	17.	Introduction, Elements of energy audits,	20
	18.	Introduction, Elements of energy audits,	
	19.	Different types of audit	
	20.	Different types of audit	
	21.	Energy use profiles	
	22.	Measurements in energy audits	
	23.	Presentation of energy audit results	
	24.	Presentation of energy audit results	
IV	25.	Distinguishing features of electricity as a commodity	20
	26.	Four pillars of market design	
	27.	Four pillars of market design	
	28.	Imbalance, Scheduling and Dispatch	
	29.	Congestion Management	
	30.	Ancillary Services	
	31.	Framework of Indian power sector and introduction to the availability based tariff (ABT)	
	32.	Framework of Indian power sector and introduction to the availability based tariff (ABT)	



V	33.	Energy – Saving Measures in New Buildings	20
	34.	Water Audit, Method of Audit	
	35.	General Energy – Savings Tips Applicable to New as well as Existing Buildings	
	36.	Scope of DSM, Evolution of DSM concept	
	37.	DSM planning and Implementation	
	38.	Load management as a DSM strategy	
	39.	Applications of Load Control	
	40.	End use energy conservation, Tariff options for DSM	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: As per university question paper pattern to attain Cos & POs	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1,2 & 3 of syllabus	9	Individual Submission in the standard format is expected	Books 1,2 and 3 of the text books.
2	Assignment 2: On line Quiz covering all modules to attain Cos & POs	Students study all the Topics and appear for online quiz to enhance subject knowledge.	Module 1-5 of the syllabus	12	Individual Submission through Online Google link.	Books 1, 2 and 3 of the text books.

13.0 QUESTION BANK

MODULE-1

1. Explain in details about primary and secondary energy sources
2. Write short note on long term energy scenario for India
3. Explain about five strategic measures for meeting energy security of a country
4. Explain the salient features of Energy Conservation Act, 2001
5. Explain briefly the energy conservation and its importance
6. Explain the need for energy Management
7. Review the energy scenario in India in brief
8. What is energy performance contracts? Elaborate the need for energy audit in industries
9. Interpret the method of evaluation of energy conservation opportunities



MODULE-2

1. What are the steps to be followed for maximum demand control, explain briefly.
2. Explain briefly about automatic power factor controllers
3. Write a short note on soft starter
4. Explain steps involved in flow control strategies in pumps
5. Explain steps involved in flow control strategies in fans
6. Explain the variable speed drives
7. Explain different types of electricity billing
8. Explain Electrical load management
9. Explain the energy efficiency in lighting system
10. Explain the efficient operation of transformers
11. Explain the efficient operation of motors

MODULE-3

1. Explain the steps in details about energy efficient lightning controls
2. Give the ten step methodology for detailed energy audit and explain
3. What is energy use profile? What are the audits required for constructing the energy use profile?
4. Explain all energy audit instruments
5. Explain elements of energy audits
6. Explain different types of audit
7. Explain the measurements in energy audits
8. Explain the energy audit results

MODULE-4

1. Explain brief four pillars of market design
2. Draw the structure of power sector and explain the India power sector model
3. Explain the concept of ABT and mention the importance of ABT
4. List out the steps to be taken for energy efficiency in building, explain in details (any three)
5. Distinguish features of electricity as a commodity
6. Explain framework of Indian power sector
7. Explain imbalance and scheduling management
8. Explain Dispatch and congestion management



MODULE-5

1. Explain briefly with block diagram about DSM planning and implementation
2. Explain the concept of load management as a DSM strategy
3. Explain the tariff options which can promote DSM activities
4. Write short note on i) Scope of DSM ii) End use energy conservation
5. Explain energy saving measures in new building
6. What are the applications of load control?
7. Explain end use energy conservation
8. Explain different tariff options for DSM
9. Explain evaluation of DSM concept
10. What are the saving tips applicable to new as well as exiting building?

Prepared by	Checked by		
			
Prof. S. J. Patil	Prof. S. D. Hirekodi	HOD	Principal



Subject Title	NON CONVENTIONAL ENERGY RESOURCES		
Subject Code	BME755D	CIE Marks	50
Number of Lecture Hrs /	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:

Name: Dr. M. M. Shivashimpi	Designation: Associate Professor	Experience: 18
No. of times course taught: 01	Specialization: Thermal Engineering	

1.0 Prerequisite Subjects:

Sl. No.	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	I/II	Mathematics, Physics and Chemistry & Renewable Energy Sources

2.0 Course Objectives

1. To introduce the concepts of solar energy, its radiation, collection, storage and application.
2. To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
3. To explore society's present needs and future energy demands.
4. To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind Power, geothermal, etc.
5. To get exposed to energy conservation methods.

3.0 Course Outcomes

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

CO'S	Course Outcome	Cognitive Level	PO's	PSO's
C411.1	Describe the environmental aspects of nonconventional energy resources in Comparison with various conventional energy systems, their prospects and limitations, the need of Renewable energy resources, historical and latest developments.	L1,L2&L3	1,2,3,6,7,8,12	1,2



C411.2	Describe the use of solar energy and the various components used in the energy production with respect to applications like heating, cooling, desalination, power generation, drying, cooking etc.	L1,L2&L3	1,2,3,6,7,8,12	1,2
C411.3	Explain the need of Wind Energy and the various components used in energy generation and know the classifications.	L1,L2&L3	1,2,3,6,7,8,12	1,2
C411.4	Understand the concept of Biomass energy resources and their classification, types of biogas Plants applications.	L1,L2&L3	1,2,3,6,7,8,12	1,2
C411.5	Compare the working principles of fuel cells wave power, tidal power and geothermal principles and applications.	L1,L2&L3	1,2,3,6,7,8,12	1,2

4.0 Course Content

Module-1

Introduction: Energy source, India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, solar, thermal, photovoltaic. Water power, wind

Biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear

(Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative).

Solar Radiation Measurement of Solar Radiation

Solar Radiation: Extra Terrestrial radiation, spectral distribution of extraterrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.

Measurement of Solar Radiation: Pyrometer, shading ring pyrliometer, sunshine recorder, schematic diagrams and principle of working.

Module-2

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, and zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sun, day length, numerical examples.

Radiation Flux on a Tilted Surface Solar Thermal Conversion

Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations) numerical example. Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, and refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems.



Module-3

Performance Analysis of Liquid Flat Plate Collectors

General description, collector geometry, selective surface (qualitative discussion) basic energy balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust.

Photovoltaic Conversion

Photovoltaic Conversion: Description, principle of working and characteristics, applications.

Module-4

Wind Energy:

Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples.

Tidal Power:

Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Ocean Thermal Energy Conversion:

Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC.

Module-5

kiu

Hydrogen Energy:

Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production biochemical production. Storage & Transportation Methods: Gaseous, cryogenic and metal hydrides, application of hydrogen, domestic and industrial safe burning of hydrogen.

Geothermal Energy Conversion:

Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.

Energy from Biomass:

Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of biogas plants, transportation of biogas, problems involved with biogas production, application of biogas, application of biogas in engines, advantages.



5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII & VIII	Project work	Implementation of renewable energy based projects

6.0 Relevance to Real World

Sl. No	Real World Mapping
01	Electrical power generation using renewable energy sources like wind and solar.
02	Generation of heat energy by using solar and biomass.
03	Conservation of non-renewable energy sources.

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Practical Assignment	Practical assignments could be given to the students to construct a model to demonstrate generation of heat and electricity using solar and wind energy.
02	Industrial visit	To provide practical exposure to the students' industrial visit to solar power plants and wind mills could be arranged.

8.0 Books Used and Recommended to Students

Text Books
1. Non Convention Energy Resources by B H Khan, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd. 2. Non-Conventional Energy Sources by G.D Rai, Khanna Publishers (2003). 3. Solar Energy by Subhas P Sukhatme, 2nd Edition Tata Mcgraw Hill (1996). 4. Renewable energy sources and Conversion technology by N.K.Bansal, Manfred Kleeman and Mechael Meliss, Tata McGraw Hill (2004).
Reference Books
1. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 1996 2. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended



Website and Internet Contents References

- E-book [URL:https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html](https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html)
- E-book [URL:https://www.pdfdrive.com/non-conventional-energy-systems-nptel-d17376903.html](https://www.pdfdrive.com/non-conventional-energy-systems-nptel-d17376903.html)
- <https://www.youtube.com/watch?v=ybZbwKIB1Ic>
- https://onlinecourses.nptel.ac.in/noc23_ge04/preview.
- <https://www.youtube.com/watch?v=LOVZE9WalRE> Fundamentals of Photovoltaic
- <https://www.youtube.com/watch?v=BcVzc6IGwS0>

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	Energy & Environment	https://en.wikipedia.org/wiki/Energy_%26_Environment
2	Journal of Renewable and Sustainable Energy	https://en.wikipedia.org/wiki/Journal_of_Renewable_and_Sustainable_Energy
3	Solar Energy Journal	https://en.wikipedia.org/wiki/Solar_Energy_(journal)
4	Renewable and Sustainable Energy Reviews	https://en.wikipedia.org/wiki/Renewable_and_Sustainable_Energy_Reviews

11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and any two Assessment methods for 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered



- Any two assessment methods mentioned in the 22OB4.2, if an assignment is project based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled down sum of two tests and other methods of assessment for a total of 50 marks. (**Duration 01 hours**)

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**Duration 03 hours**).

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1		Introduction:	20
	1	Energy source, India's production and reserves of commercial energy sources,	
	2	need for non-conventional energy sources	
	3	Energy alternatives, solar, thermal, photovoltaic. Water power, wind	
	4	Biomass, ocean temperature difference, tidal and waves, geothermal	
	5	tar sands and oil shale, nuclear (Brief descriptions) Advantages and disadvantages, comparison (Qualitative and Quantitative).	
		Solar Radiation Measurement of Solar Radiation	
	6	Solar Radiation: Extra Terrestrial radiation, spectral distribution of extraterrestrial radiation	
	7	solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.	
	8	Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.	



2		Solar Radiation Geometry:	40
	9	Flux on a plane surface, latitude, declination angle	
	10	surface azimuth angle, hour angle, and zenith angle	
	11	Solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time.	
	12	Apparent motion of sun, day length, numerical examples.	
		Radiation Flux on a Tilted Surface Solar Thermal Conversion	
	13	Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations) numerical example.	
	14	Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis)	
3	15	Sensible heat storage, latent heat storage, application of solar energy water heating.	60
	16	Space heating and cooling, active and passive systems, power generation, and refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems.	
		Performance Analysis of Liquid Flat Plate Collectors	
	17	General description, collector geometry, selective surface (qualitative discussion)	
	18	basic energy balance equation, stagnation temperature, transmissivity of the cover system	
	19	transmissivity – absorptivity product, numerical examples.	
	20	The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided).	
	21	Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided).	
4	22	Effect of various parameters on the collector performance	80
	23	Collector orientation, selective surface, fluid inlet temperature, number covers, dust.	
		Photovoltaic Conversion	
	24	Photovoltaic Conversion: Description, principle of working and characteristics, applications.	
		Wind Energy:	
	25	Properties of wind, availability of wind energy in India,	
	26	wind velocity and power from wind;	
	27	major problems associated with wind power, wind machines;	
4	28	Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles;	80
	29	Coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples.	
		Tidal Power:	
	30	Tides and waves as energy suppliers and their mechanics;	
	31	Fundamental characteristics of tidal power, harnessing tidal energy, limitations.	
		Ocean Thermal Energy Conversion:	
	32	Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC.	



5		Hydrogen Energy:	100
	33	Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen	
	34	Production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production biochemical production.	
	35	Storage & Transportation Methods: Gaseous, cryogenic and metal hydrides,	
	36	Application of hydrogen, domestic and industrial safe burning of hydrogen.	
		Geothermal Energy Conversion:	
	37	Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.	
		Energy from Biomass:	
	38	Photosynthesis, photosynthetic oxygen production, energy plantation,	
	39	biogas production from organic wastes by anaerobic fermentation, description of biogas plants, transportation of biogas,	
	40	Problems involved with biogas production, application of biogas, application of biogas in engines, advantages.	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Introduction to Non-conventional energy Resources, Solar Radiation Measurement of Solar Radiation	Students study the Topics and write answer. Get practice to solve university questions.	1,2 module of the syllabus	04	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
2	Assignment 2: Wind Energy, Biomass energy, wave energy, tidal energy, OTEC and green energy.	Students study the Topics and write answer. Get practice to solve university questions.	3,4,5 module of the syllabus	09	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
3	Quiz: All the module	Students study the Topics and prepare the multiple choice questioner with answer.	5 Module of the syllabus	13	Group Activity.	Book 1, 2 of the reference list. Website of the Reference list



14.0 QUESTION BANK

Sample Questions	Questions
I	Module 1 1. Enlist and explain the merits and demerits of any 3 non-conventional energy sources. 2. Explain tar sands and oil shale as energy source and mention their limitations. 3. With schematic representation, explain mechanism of absorption, scattering beam and diffuse radiation received at earth's surface. 4. Explain with a neat sketch, explain the working of pyrenometer. 5. Explain briefly the need for alternate energy sources.
II	Module 2 1. Define the following terms with respect to solar radiation i) hour angle ii) declination angle iii) zenith angle iv) latitude angle v) solar azimuth angle. 2. Calculate the day length of location (latitude 22° 00' W, 73° 10' E) during the month of March 1. 3. With the usual expression for flux explain beam and diffuse radiation on a tilted surfaces. 4. With a neat sketch explain working of liquid flat plate collector. 5. Describe solar pond for solar energy collection and storage. 6. Explain how solar energy can be used for drying with a neat sketch. 7. Calculate the angle of incidence of beam radiation on a plane surface, tilted by 45° from horizontal plane and pointing 30° west of south located at Mumbai at 1.30 PM (IST) on 15th November . The longitude and latitude of Mumbai are 72°49' E and 18°54' N respectively. The standard longitude for IST 81°44'.
III	Module 3 1. List and discuss the various parameters that affect the performance of collector. 2. Explain the heat transfer process in LFPC with neat sketch and write energy balance equation, explaining each terminal. 3. Explain the working principle and I-V characteristics of PV cell. 4. Define i) collector efficiency factor ii) collector heat removal factor of LPFC write expression for the above. 5. What are the applications of solar PV cell? 6. Plot the variation of τ_r, τ_a and τ with the angle of incident for the following cover system Material : glass, Number of covers : 3, Thickness of each cover (δ_c) = 4 mm , Refractive index of glass relative to air (n_2) = 1.52 , extinction coefficient of glass (K)= 15 m⁻¹ and angle of incidence (θ_1) = 15°. Assume $n_1 = 1$.
IV	Module 4 1. Describe the main consideration in selecting the site for wind generators. 2. Explain With Neat Sketch The Closed Rankine Cycle OTEC System. 3. Explain Briefly The Harnessing Of Tidal Energy. 4. Explain advantages and disadvantages of tidal energy. 5. The wind blows with a velocity of 16m/s and 15°C. Assume 1 standard atmospheric pressure and turbine diameter = 115 m with operating speed = 40 rpm at maximum efficiency, calculate the following i) Total power density in wind stream ii) Maximum obtainable power density iii) Reasonable obtainable power density iv) Total power v) Torque and axial thrust.



V	Module 5
	1. What Are Fuel Cells
	2. Classify Fuel Cells
	3. Explain The Operating Principles Of Fuel Cells
	4. Explain Zero Energy Concepts.
	5. What Are The Benefits Of Hydrogen Energy
	6. Explain Hydrogen Production Technologies Electrolysis Method
	7. Describe Hydrogen Energy Storage
	8. Give Applications Of Hydrogen Energy
	9. What Are The Problems Associated With Hydrogen Energy?
	10. State The Environmental Problem Associated With Geothermal Energy Conversion
	11. List The Factors Affecting The Biogas Generation
	12. Sketch and explain the working of fixed dome type biogas plant used in India

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