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.

DEPARTMENT VISION

To be a centre of excellence in teaching and learning to produce the competent & socially responsible professionals in the domain of Electrical & Electronics Engineering.

DEPARTMENT MISSION

I. To educate students with core knowledge of Electrical and Electronics Engineering to excel in their professional career.

II. To develop problem solving skills, professional skills and ethical values among the students for the betterment of mankind.

III. To prepare technically competent and socially responsible Electrical Engineer to serve the future needs of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the program will be able to

PEO1: Achieve successful professional career in Electrical Engineering and allied disciplines.

PEO2: Pursue higher studies and continuously engage in upgrading the professional skills.

PEO3: Demonstrate professional & ethical values, effective communication skills and teamwork to solve issues related to profession, society and environment.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

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.

PROGRAM SPECIFIC OUTCOMES (PSOs) :

PSO1: Apply knowledge & competencies to analyze & design Electrical & Electronics Circuits, Controls and Power Systems, Machines & Industrial Drives.

PSO2: Use Software/Hardware tools for the design, simulation and analysis of Electrical and Electronics Systems.

Contents of V - SEM

S N	TOPIC	PAGE NO
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7	**Course Plans , Question Bank & Assignment Questions**	
	Courses	
	BEE501-Engineering Management and Entrepreneurship	
	BEE502-Signals & DSP	
	BEE503-Power Electronics	
	BEEL504-Power Electronics Lab	
	BEE515A-High Voltage Engineering	
	BRMK557-Research Methodology and IPR	
	BESK508-Environmental Studies	

HSMS: -Humanity and Social Science and management Course, **PCC:** Professional Core Course, **IPCC:** Professional Core Course Theory Integrated with practicals, **PCCL:** Professional Core Course laboratory, **AEC:** Ability Enhancement Course, **ESC:** Engineering Science Course, **MC:** Mandatory Course (Non-credit), **PEC:-** Professional Elective Course, **OEC**:- Open Elective Course

1.0 Student Help Desk

Sl. No	Coordination Work	Contact Person	
		Faculty	Instructor
01	Attestations	Dr. B. V. Madiggond	-
02	Exam forms signature, Overall department administration, Counseling/ interaction with Parents/Students.		
03	Research Centre Coordinator		
04	Project Coordinator, KSCST Coordinator, Hobby & Mini Project Coordinator,	Prof. O. B. Heddurshetti	-
05	Academic Coordinator, Dept. Library Coordinator, Mentorship Coordinator	Prof. H. R. Zinage	-
06	First Year Coordinator, Dept. NBA Coordinator, Alumni Coordinator	Dr. M. P. Yenagimath	-
07	Dept. Association Coordinator, Professional Body (ISTE & IEEE) Coordinator	Prof. S. D. Hirekodi	-
08	AICTE/VTU/NIRF/LIC Coordinator, AICTE Activity Coordinator	Prof. A. U. Neshti	-
09	IA & EMS Coordinator	Prof. S. J. Patil	Shri. G. B. Rendale
10	News letter/Technical Magazine Coordinator, News & Publicity Coordinator, Website Coordinator,	Prof. S. G. Huddar	--
11	TP Cell Coordinator, IIIC Cell, Internship Coordinator	Prof. P. I. Savadatti	--
12	Dispensary	Dr. Arun G. Bullannavar, Contact No.9449141549	
Class Teacher			
13	3rd Semester	Prof. S. J. Patil	Shri. V.M. Mutalik
14	5th Semester	Prof. A. U. Neshti	Shri. G. B. Rendale
15	7th Semester	Prof. P. I. Savadatti	Shri. R. S. Bardol

2.0 Departmental Resources

Department of Electrical and Electronics Engineering was established in the year 1996 and is housed in a total area of **1339 Sq. Mtrs.**

2.1 Faculty Position

S.N.	Category	No. in position	Average experience
1	Teaching faculty	9	20 Y
2	Technical supporting staff	3	29 Y
3	Helper	2	23 Y

2.2 Major Laboratories

SL. No.	Name of the laboratory	Area in Sq. Mtrs	Amount Invested (Rs)
01	Electronics Lab	71	4,49,488.00
02	Operational Amplifier & Linear Integrated Lab		1,29,776.00
03	Power Electronics Lab	92	7,85,162.00
04	Control Systems Lab		2,14,127.00
05	Power System Simulation Lab	71	17,95,111.00
06	Computer Aided Electrical Drawing Lab		6,50,988.40
07	Microcontroller Lab/ Digital Signal Processing Lab	72	5,94,122.00
09	Electrical Machines Lab	200	14,85,725.0
10	Relay & High Voltage Lab	94	11,72,383.00
11	Basic Electrical Engg. Lab	96	42,321.00
	Total	**696**	73,19,203.40

3.0 Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
01	Dr.B.V.Madiggond	HOD/Prof.	Ph.D	Power Electronics	LMISTE, YHAI	-	33	9343454993
02	Dr. M. P.Yenagimath	Asst. Prof.	Ph.D	VLSI&ES	LMISTE	1	20	9341449466
03	Prof.S.D.Hirekodi	Asst. Prof.	M. Tech.	Power Electronics	LMISTE	1	26	9480849338
04	Prof.H.R.Zinage	Asst. Prof.	M. Tech.	Power System	LMISTE	-	26	9480849335
05	Prof.O.B. Heddurshetti	Asst. Prof.	M. Tech.	Power Electronics	LMISTE	1	19	9448420509
06	Prof. A. U. Neshti	Asst. Prof.	M. Tech.	Digital Electronics	ISTE	-	18	9538223362
07	Prof. S. G. Huddar	Asst. Prof.	M. Tech.	Power System Engg.	LMISTE	-	13	9742066852
08	Prof. P. I. Savadatti	Asst. Prof.	M. Tech.	Digital Electronics	-	-	11	9964315436
09	Prof. S. J. Patil	Asst. Prof.	M. Tech.	Industrial Electronics	-	-	15	9880931802

4.0 Institute Calendar of Events

S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
Approved by AICTE, New Delhi amd Affiliated to VTU, Belagavi
Recognized under 2(f) & 12B of UGC Act, 1956 & Accredited at 'A+' Grade by NAAC

IQAC | AY:2026-27 | CoE for Odd Sems

Comprehensive Calendar of Events (CoEs)

(I, III, V & VII Sems. for the AY: 2026-27)

Ref: 1) VTU Notification on the Revised Academic Calendar bearing no.: No.: VTU/BGM/BoS/1st sem AC/ 2026-27/2465, Dated: 18th Aug. 2026
2) Notification on the Tentative Academic Calendar bearing no.: No.: VTU/BGM/BoS/5th sem AC/ 2026-27/2125, Dated: 30th July. 2026
3) Notification on the Tentative Academic Calendar bearing no.: No.: VTU/BGM/BoS/3rd sem AC/ 2026-27/2124, Dated: 30th July. 2026
4) AICTE Academic Calendar: 2026-27, June Session, File No.: AICTE/RB-AC-2026-27/2, Dated: 13th Aug. 2026

August-2026

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31					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

15th Aug. 2026 GH: Independence Day
26th Aug. 2026 GH: Eid-e-Milad

September-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			

14th Sept. 2026 GH: Ganesha Chaturthi
7th Sept. 2026 LH: Last Shravana Monday
17th Sept. 2026 LH: Mahadasoha of Shri Math Nidasoshi (Tentative)

October-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

2nd Oct. 2026 GH: Gandhi Jayanti
10th Oct. 2026 GH: Mahalaya Amavasya
20th Oct. 2026 GH: Mahanavami/Ayudh Pooja
21st Oct. 2026 GH: Vijaya Dashami

November-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					

1st Nov. 2026 GH: Kannada Rajyotsav
8th Nov. 2026 GH: Narak Chaturdashi
10th Nov. 2026 GH: Balipadyami/Deepavali
27th Nov. 2026 GH: KanakdasJayanti

December-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		

25th Dec. 2026 GH: Christmas

January-2027

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31					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

14th Jan. 2027 GH: Makar Sankranti
26th Jan. 2027 GH: Republic D[illegible]

Date	Events
24th -29th Aug. 2026	I, III & V Sems. Finalization of Electives, Academic Work load Distribution, Display of e-CPs & CIE in OBE-ERP & Time-Table/s
24th -29th Aug. 2026	Commencement of I Sem. SIP
31st Aug. 2026	Orientation Programs & Commencement of I Sem. Classes
13th -14th Aug. 2026	International Conference IC-DAIS 2026 (By: R&D Cell)
20th -22nd Aug. 2026	1st IAT & CCAs for VII Sem. (on CO1)
22nd Aug. 2026	1st e-Feedback on T&L of VII Sem Students
25th Aug. 2026	e-Display of 1st IAT & CCAs marks for VII Sem.
29th Aug. 2026	1st Counseling of VII Sem Mentees by Mentor
5th Sept. 2026	Teachers' Day Celebration (Org. by NSS)
7th & 8th Sept. 2026	Commencement of Classes for V & III Sems. resply (AY:2026-27)
11th Sept. 2026	Commencement of IDT Lab (Completion of 3 IDT Steps)
11th Sept. 2026	Alumni Association Activity (Tentative) (Org. by HAA)
12th Sept. 2026	Workshop on Women's Empowerment & Health (Org. by WEC)
15th Sept. 2026	Engineers' Day Celebration (Org. by NSS)
23rd Sept. 2026	I Sem. Fresher's' Day Celebration (Org. by FY Dept.)
24th -26th Sept. 2026	2nd IAT& CCAs for VII Sem. (on CO2 & CO3)
26th Sept. 2026	2nd e-Feedback on T&L of VII Sem Students
26th Sept. 2026	Project Synopsis Presentation & CIE-01 for IDT, Community & Mini Projects' of I, III & V resply.
30th Sept. 2026	e-Display of 2nd IAT & CCAs marks for VII Sem.
22nd Sept. 2026	HSIT QUEST (Host by EEE Dept.) (Tentative)
30th Sept. 2026	Last date to complete the assessment of COs/POs/PSOs of AY:2025-26 through direct & indirect methods in OBE-ERP (NBA Coordinator)
2nd Oct. 2026	International Day of Non-Violence (Org. by NSS & YRC)
1st Oct. 2026	Blood Donation Day (Org. by YRC & NSS)
14th -16th Oct. 2026	1st IAT & CCAs for I, III & V Sems. (on CO1 & CO2)
16th Oct. 2026	1st e-Feedback on T&L of I, III & V Sems. Students
9th Oct. 2026	Academic Audit of the AY:2025-26 (By Dept.) Green/Energy Audit (By NSS) & Gender Audit (By WEC) (Tentative)
9th Oct. 2026	Annual Sports Day (Host by SD)
12th -15th Oct. 2026	Fun Week & Dusserha Activities (Host by ECE Dept.) (Tentative)
16th Oct. 2026	HSIT Sambhrama (Host by ECE Dept.) (Tentative)
23rd Oct. 2026	e-Display of 1st IAT & CCAs marks for I, III & V Sems.
24th Oct. 2026	1st Lab IAT & Display of marks for I, III & V Sems. (on CO1 & CO2)
27th Oct. 2026	1st Counseling of I, III & V Sems. Mentees by Mentor
29th -31st Oct. 2026	3rd IAT & CCAs for VII Sem. (on CO4 & CO5)
31st Oct. 2026	Project work (Phase-2) Exhibition cum Demonstration (VII Sem.)
3rd Nov. 2026	e-Display of 3rd IAT & CCAs marks for VII Sem.
4th Nov. 2026	2nd Lab IAT & Display of marks for VII Sem (on CO3-CO5)
9th Nov. 2026	Last Working Day of VII Sem.
14th Nov.- 4th Dec. 26	VII Sem Theory SEE
1st Dec. 2026	2nd e-Feedback on T&L of I, III & V Sems. Students
4th Dec. 2026	2nd Lab IAT & Display of marks for I Sem (on CO3-CO5)
7th- 18th Dec. 26	VII Sem Practical SEE
21st Dec. 2026	Commencement of VIII Sem (AY: 2026-27) (15 Weeks Industry Internship & MOOCs by VTU-CoE
26th Dec. 2026	Project Exhibition cum Demonstration & CIE-01 for IDT , Community & Mini Projects' of I, III & V resply.
22nd -24th Dec. 2026	2nd IAT & CCAs for I, III & V Sems. (on CO3, CO4 & CO5)
24th Dec. 2026	2nd Counseling of I, III & V Sems. Mentees by Mentor
28th Dec. 2026	e-Display of 2nd IAT & CCAs marks for I, III & V Sems.
30th Dec. 2026	Last Working Day of III & V Sems.
1st Jan. 2027	Last Working Day of I Sem.
4th Jan-5th Feb. 27	1st , 3rd & 5th Sems. Theory Examinations
12th Jan. 2027	National Youth Day & NMBA & Integrity Pledge (Org. by NSS, Sports & YRC)
1st -20th Feb. 27	1st , 3rd & 5th Sems. Practical Examinations
30th Jan. 2027	Martyrs' Day (Shaheed Diwas) (Org. by NSS, SD & YRC)
16th Feb. 2027	Commencement of II Sem
22nd Feb. 2027	Commencement of IV & VI Sems.

Important Note

1) *Dept. must plan for extra sessions on weekdays, Saturdays, and Sundays to complete the VTU prescribed syllabus within term end as per the VTU guidelines.*
2) *Every 1st & 3rd Saturday will be holiday as per VTU notification*
3) *Dept. shall adhere to the VTU guidelines for swappable 2022 scheme 7th & 8th semester Internship & Elective-MOOCs conducted by VTU- Centre for Online Education (COE)*

Abbreviations

IAT: Internal Assessment Test, T&L: Teaching & Learning Process, GH: General Holiday, CCA: Continuous Comprehensive Assessments, LH: Local Holiday, CO: Course Outcome, NSS: National Service Scheme, SD: Sports Dept. WEC: Women Empowerment Cell, YRC: Youth Red-Cross, OBE-ERP: OBE-ERP Software, MOOC: Massive Open Online Course, SEE: Semester End Examination, SIP: Student Induction Program NMBA: Nasha Mukta Bharat Abhiyan, HAA: HSIT Alumni Association, R&D: Research & Development

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

Dr.S.C.Kamate
Principal

Nidasoshi, Tal: Hukkeri, Dist: Belgaum, Karnataka - 591 236, Phone:+91-8333-278887, Fax:278886, Web: www.hsit.ac.in

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electrical & Electronics Engineering

Scheme of Teaching and Examinations2022

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

(Effective from the academic year 2023-24)

V 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	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	HSMS	BEE501	Engineering Management and Entrepreneurship	Any branch /EEE	3	0	0		03	50	50	100	3
2	IPCC	BEE502	Signals & DSP	EEE	3	0	2		03	50	50	100	4
3	PCC	BEE503	Power Electronics	EEE	4	0	0		03	50	50	100	4
4	PCCL	BEEL504	Power Electronics Lab	EEE	0	0	2		03	50	50	100	1
5	PEC	BEE515x	Professional Elective Course	EEE	3	0	0		03	50	50	100	3
6	PROJ	BEE586	Mini Project	EEE	0	0	4		03	100		100	2
7	AEC	BRMK557	Research Methodology and IPR	Any Department	2	2	0		02	50	50	100	3
8	MC	BESK508	Environmental Studies	TD: Civil/Biotech/Chemistry PSB: As specified by the University	2	0	0		02	50	50	100	2
9	MC	BNSK559	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		BPEK559	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK559	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**22**

@#@

Professional Elective Course			
BEE515A	High Voltage Engineering	BEE515C	Electric Vehicle Fundamentals
BEE515B	Power Electronics for Renewable Energy Systems	BEE515D	Fundamentals of VLSI Design

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project 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.

No SEE component for Mini-Project.

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 a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Subject Title	**ENGINEERING MANAGEMENT AND ENTREPRENEURSHIP**		
Subject Code	BEE501	**CIE Marks**	50
Number of Lecture Hrs / Week	03	**SEE Marks**	50
Total Number of Lecture Hrs	40	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof: Hemalata R Zinage	**Designation:** Asst. Professor	**Experience: 25** Years
No. of times course taught: 05	**Specialization:** Power system	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
--	--	--	--

2.0 Course Objectives:

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

- Understand basic skills of Management.
- Understand the need of Entrepreneurs and their skills.
- Identify the Management functions and Social responsibilities.
- Understand the identification of Business, drafting the Business plan and sources of funding.

3.0 Course Outcomes

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

	Course Outcome	**RBT Level**	**Pos**
C301.1	Understand the fundamental concepts of Management and its functions.	L3	6-12
C301.2	Understand the different functions to be performed by managers/Entrepreneur.	L3	6-12
C301.3	Understand the social responsibilities of a Business.	L3	6-12
C301.4	Understand the concepts of Entrepreneurship and to identify Business opportunities.	L3	6-12
C301.5	Understand the components in developing a business plan and awareness about various sources of funding and Institutions supporting Entrepreneur.	L3	6-12
Total Hours of Pedagogy		**40 hours**	

4.0 Course Content

Module-1

Management: Nature and functions of Management- Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession**.**

Planning: Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning, Types and Steps in Decision Making.

Module-2

Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only) Departmentalization - Process of Departmentalization, Purpose of Departmentalization, Committees – meaning, Types of Committees.

Staffing-Need and importance, Recruitment and Selection Process.

Directing and Controlling: Meaning and Requirements of Effective Direction, Giving Orders; Motivation-Nature of Motivation, Motivation Theories (Maslow's Need-Hierarchy Theory and Herzberg's Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication.

Module-3

Leadership-Meaning, characteristics, Behavioural Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling-Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process.

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.

Module-4

Entrepreneurship: Introduction, Evolution of the concept of Entrepreneurship, Entrepreneurship today, Types of Entrepreneurs, Entrepreneurship, Entrepreneurial competencies, Capacity Building for Entrepreneurs.

Identification of Business Opportunities: Introduction, Mobility of Entrepreneurs, Business opportunities in India, Models for opportunity Evaluation.

Module-5

Business plans: Introduction, purpose of Business plan, contents of a Business plan, presenting a Business plan, why do some Business plans fail? Procedure for setting up an Enterprise.

Institutions Supporting Business opportunities: Central–Level Institutions – National Board for micro, small & medium Entreprises (NBMSME), MSME-DO, National small Industries Corporation. State level institutions- state Directorate Industries and commerce, District Industries Centers, state financial Corporations, State Industrial Development Corporation (SIDC), State Industrial Area Development Board (SIADB). Other Institutions- NABARD, Technical consultancy organization (TCO), Small Industries Development Bank of India (SIDBI), Export Promotion Councils, Non governmental Organisations.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Project planning

6.0 Relevance to Real World

Sl No	Real World Mapping
01	Planning in an industry
02	Various organizational structures
03	Development of a project cases

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Activity	Group discussion on a trending topic to build communication skills.

8.0 Books Used and Recommended to Students

Text Books				
1.	Principles of Management	P.C. Tripathi, P.N.Reddy	McGraw Hill,	6th Edition, 2017
2.	Entrepreneurship Development and Small Business Enterprises	Poornima M. Charanthimath	Pearson	2nd Edition,2014

Reference Books

1. Dynamics of Entrepreneurial Development and Management Vasant Desai Himalaya Publishing House 2007
2. Essentials of Management: An International, Innovation and Leadership perspective Harold Koontz, Heinz Weihrich McGraw Hill 10th Edition 2016

Additional Study material & e-Books

1.Iyer, P.P., Engineering Project Management with Case Studies, Vikas Publishing, New Delhi, 2009.
2.Zikmund, W.G., Business Research Methods, 5th Edition, New York, The Dryden Press, Harcount Publishers, 1997.
3.M Govindarajan and S. Natarajan, Principles of Management, Eastern Economy Edition, 2005.

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

Website and Internet Contents References
1) https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/video-tutorials/lecture-1/
2) https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/video-tutorials/lecture-2/
3) https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/video-tutorials/lecture-4/
4) https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/video-tutorials/lecture-5/
5) https://nptel.ac.in/courses/110107094
6) https://nptel.ac.in/courses/110106141
7) https://nptel.ac.in/courses/122106031

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Academy of management journal	http://libguides.usc.edu.au
2	International journal of economics and financial review	http://www.sciencedirect.com/science/journal/00207683
3	International journal of human resource management.	http://libguides.usc.edu.au

11.0 Examination Note

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 marks 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 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:

- For the assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 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 assignment methods mentioned in the 220B2.4, if an assignment is project –based then only one assignment for the courses 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 scaled-down sum of two tests and other methods of assessment.

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

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1.	**Management:** Nature and functions of Management- Importance, Definition.	20
	2.	Management Functions, Levels of Management	
	3.	Roles of Manager, Managerial Skills	
	4.	Management & Administration, Management as a Science, Art & Profession	
	5.	**Planning:** Nature of planning	
	6.	Importance & Types of planning	
	7.	Steps and Limitations of Planning	
	8.	Decision Making – Meaning, Types and Steps in Decision Making.	

2	9.	**Organizing and Staffing:** Organization-Meaning and Characteristics	20
	10.	Process and Principles of Organizing, Span of Management	
	11.	Departmentalization - Process of Departmentalization, Purpose of Departmentalization	
	12.	Committees – meaning and Types of Committees.	
	13.	Staffing-Need and importance, Recruitment and Selection Process	
	14.	**Directing and Controlling:** Meaning and Requirements of Effective Direction	
	15.	Motivation-Nature of Motivation, Motivation Theories	
	16.	Communication – Meaning, Importance and Purposes of Communication.	
3	17.	**Leadership**-Meaning and characteristics	20
	18.	Behavioral Approach of Leadership	
	19.	Coordination-Meaning, Types, Techniques of Coordination	
	20.	Controlling-Meaning, Need for Control System, Benefits of Control	
	21.	Essentials of Effective Control System, Steps in Control Process	
	22.	**Social Responsibilities of Business:** Meaning of Social Responsibility	
	23.	Social Responsibilities of Business towards Different Groups, Social Audit	
	24.	Business Ethics and Corporate Governance.	
4	25.	**Entrepreneurship**: Introduction	20
	26.	Evolution of the concept of Entrepreneurship	
	27.	Entrepreneurship today, Types of Entrepreneurs, Entrepreneurship	
	28.	Entrepreneurial competencies, Capacity Building for Entrepreneurs	
	29.	**Identification of Business Opportunities**: Introduction	
	30.	Mobility of Entrepreneurs	
	31.	Business opportunities in India	
	32.	Models for opportunity Evaluation	
5	33.	**Business plans**: Introduction, purpose of Business plan	20
	34.	Contents of a Business plan, presenting a Business plan	
	35.	Procedure for setting up an Enterprise.	
	36.	**Institutions Supporting Business opportunities:** Central–Level Institutions – National Board for micro, small & medium Enterprises (NBMSME), MSME-DO, National small Industries Corporation	
	37.	State level institutions- state Directorate Industries and commerce	
	38.	District Industries Centers, state financial Corporations, State Industrial Development Corporation (SIDC)	
	39.	State Industrial Area Development Board (SIADB). Other Institutions- NABARD, Technical consultancy organization (TCO),	
	40.	Small Industries Development Bank of India (SIDBI), Export Promotion Councils, Nongovernmental Organizations.	

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: University Questions on management & Planning.	Students study the Topic and write the Answers. Get practice to solve university questions.	module 2 of the syllabus	2	Individual Activity. Written answers are expected.	Text book 1
2	Assignment 2: University Questions on organizing, staffing, directing & controlling.	Students study the Topic and write the Answers. Get practice to solve university questions.	module 4 of the syllabus	4	Individual Activity. Written answers are expected.	Text book 1

14.0 QUESTION BANK

MODULE 1

1. Explain management –A science, art or profession?
2. Bring out the differences between management and administration.
3. Define management and describe the functions of the management.
4. What are the roles of manager? Explain.
5. Explain various functions of management.
6. Explain the different levels of management.
7. Explain various roles of management.
8. Explain modern management approaches.
9. Explain scientific management.
10. Is management is science or an art? Explain.
11. Explain various functional areas of management.
12. What is scientific management? Explain Taylor's scientific principles of management.
13. Explain contributions of FW Taylor's to the development of management thought.
14. Explain the principles of management.
15. Explain early management approaches.
16. Explain behavior approach to management.
17. Explain quantitative approach to management.
18. Explain the levels & Roles of Management.
19. What is contingency approach? Explain.
20. Define the term planning and explain its importance.
21. Explain the importance of planning. Mention its limitations.
22. What are the major drawbacks in planning? Explain.
23. Explain the significance of planning and its influence on other managerial functions.
24. Explain principles of planning.
25. What are the planning premises? Explain the classification of planning premises with examples.
26. What are the key features of planning?
27. Explain steps involved in planning.
28. Classify plans on the basis of hierarchy level at which plans are made.
29. Differentiate between strategic and operational plans.
30. What are single use and standing plans? Explain with examples.
31. What are objectives? Explain characteristic of objectives.
32. Explain importance of objectives.
33. Define the objectives. Discuss the characteristics of business objectives.
34. Briefly explain the types of planning.

MODULE 2

1. Define the term organization. Explain the purpose of organization.
2. Explain different types of organizations.
3. Explain the process of selection and recruitment.
4. Difference between formal and informal organization.
5. What is organizing? Explain the steps involved in organizing.
6. Explain the nature and purpose of an organization.
7. Explain the principles of organization.
8. What is an organization chart? What is line organization? Explain.
9. What is functional organization? Explain.
10. Differentiate between line and functional organization.
11. What is line and staff organization? Explain.
12. What are committees? Explain principles of committees.
13. What is committee organization?
14. What is directing? Explain the importance of directing.
15. Explain the behavioral approach of leadership style
16. Define the term leadership. Explain the qualities of a good leader.
17. Differentiate between managers and leaders.
18. Explain the nature and importance of staffing.
19. What are the various elements of staffing? Explain
20. Explain the techniques of selection.
21. Differentiate between recruitment and selection.
22. What is recruitment? Explain various sources of recruitment.
23. Explain the essentials of sound control system.
24. Briefly explain comparison of Maslow's and Herzberg theories of human motivation.

25. Give principles of directing. Differentiate between autocratic, participative and free-rein styles of leadership..
26. What is two factor theory? Explain.
27. Compare different theories of motivation.
28. What is communication? Explain its importance.
29. Explain different types of communication.
30. What are barriers to communication? Explain.

MODULE 3

1. Describe the characteristics of leadership.
2. Differentiate between autocratic and democratic styles of leadership.
3. List various theories of leadership.
4. Are leaders made born? Justify.
5. Explain the different techniques of Coordination
6. State and explain steps in controlling.
7. What is controlling? Explain its importance.
8. What are the different types of steps involved in controlling process?
9. Explain how controlling is related to planning.
10. Explain principles of controlling.
11. Discuss the process of controlling.
12. What is coordination? Explain the need of coordination.
13. What are the various techniques of coordination?
14. Define meaning of social responsibility
15. Discuss social audit
16. Explain business ethics and corporate governance.

MODULE 4

1. Define entrepreneurship. Explain the functions of entrepreneur.
2. Write and explain types of entrepreneur.
3. Who is an entrepreneur and how is he different from a businessman?
4. Differentiate entrepreneur and entrepreneurship.
5. Tabulate the changing definition of entrepreneur and entrepreneurship.
6. Discuss the characteristics of entrepreneurs.
7. Discuss in detail how entrepreneurs view risk.
8. Describe the entrepreneurial process.
9. Describe role of entrepreneurs in economic development.
10. Discuss the evolution and growth of industrial entrepreneurship in India.
11. Describe the various problems faced by entrepreneurs in promotion of their units.
12. Discuss the scope of entrepreneurship in India.
13. Explain evolution of entrepreneurship.
14. Explain the difference between entrepreneurs, entrepreneurs' and managers.
15. Explain the types of entrepreneur.
16. What are the barriers of entrepreneurship?
17. Define Micro, small and medium enterprises.
18. Discus the impact of Globalization on Small Scale Industries in India.
19. Define SSI. Enumerate various objectives of SSI.
20. Discuss the major areas of Business Opportunities available in India.
21. How capacity building can be done for Entrepreneurs.
22. What is mobility of Entrepreneurs. Discuss its various types.
23. Explain various models used for opportunity evaluation (SWOT, PESTLE, Posters Five Forces)

MODULE 5

1. Explain the purpose of business plan
2. Discuss the procedure for setting up an enterprise.
3. Explain the contents of business plan
4. Explain why some of the business plans will fail?
5. List out and explain which are the central level institutions will create the business opportunities.
6. Explain how the state level institutions are helpful to create the business opportunities.
7. Explain how SIADB and SIDC are useful to create business opportunities.
8. Write a note on
   i. Export Promotion Councils ii. Nongovernmental Organizations
9. Explain the functions & Objectives of SFC, TCO
10. What are the major activities of Export Promotion Council in encouraging exports from India.
11. How do non-governmental organizations (NGOs) contribute to the promotion of Entrepreneurship.
12. Describe the roll of SIDBI in financing MSMEs.

Prepared by	Checked by		
Prof. Hemalata R Zinage	**Prof. Hemalata R Zinage**	**HOD**	**Principal**

Course	**SIGNAL & DIGITAL SIGNAL PROCESSING**		
Course Code	**BEE 502**	**CIE Marks**	50
No of Lecture Hrs /week(L:T:P:S)	3:0:2:0	**SEE Marks**	50
Total Number of Lecture Hrs	40 hours Theory + 12 Lab slots	**Exam Hours**	03
		CREDITS – 04	

FACULTY DETAILS:		
Name: Prof. A. U. Neshti	**Designation:** Asst. Professor	**Experience:** 17 years 6 months
No. of times course taught:06	**Specialization:** Digital Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	III	Electrical circuit analysis

2.0 Course Objectives

1. To explain basic signals, their classification, basic operations on signals, and the properties of the systems.
2. To explain the convolution of signals in continuous and discrete time domain and the properties of impulse response representation.
3. To explain the computation of Discrete Fourier Transform of a sequence by direct method, Linear transformation Method and using Fast Fourier Transformation Algorithms.
4. To explain design of IIR all pole analog filters and transform them into digital filter using Impulse Invariant and Bilinear transformation Techniques and to obtain their Realization.
5. To explain design of FIR filters using Window Method and Frequency Sampling Method and to obtain theirRealization.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to:

	Course Outcome	Cognitive Level	
C302.1	Discuss classification and basic operations that can be performed on both continuous and discrete time signals and to understand sampling theorem.	L1-L4	PO1,PO2,PO3, PO8,PO9,PO12
C302.2	Evaluate Discrete Fourier Transform of a sequence, to understand the various properties of DFT and signal segmentation using overlap and overlap add method.	L1-L4	PO1,PO2,PO3, PO8,PO9,PO12
C302.3	Evaluate Discrete Fourier Transform of a sequence using decimation in time and decimation in frequency methods.	L1-L4	PO1,PO2,PO3, PO8,PO9,PO12
C302.4	To design Butterworth and Chebyshev IIR digital filters and to represent the filters using different methods and to represent IIR filter using different methods.	L1-L4	PO1,PO2,PO3, PO8,PO9,PO12
C302.5	To design FIR filters using windows method and frequency sampling method and to represent FIR filters using direct method and lattice method.	L1-L4	PO1,PO2,PO3, PO8,PO9,PO12
Total Hours of instruction		**52**	

4.0 Course Content

Module-1

Introduction: Signal ,System and signal processing, Classification of Signals, Basic Operations on Signals, Basic Elementary Signals, properties of systems , concept of frequency in continuous and Discrete time signals, sampling of analog signals, the sampling theorem , quantization of continuous amplitude and sinusoidal signals , coding of quantized samples, digital to analog conversion,

Time-domain representations for LTI systems: Convolution, impulse response representation, ConvolutionSum and Convolution Integral. Properties of impulse response representation, solution of difference equations

Module-2

Discrete Fourier Transforms (DFT):

Discrete Fourier Transforms (DFT): Introduction to DFT, definition of DFT and its inverse, matrix relation to find DFT and IDFT ,Properties of DFT, linearity, circular time shift, circular frequency shift, circular folding, symmetry of : real valued sequences, real even and odd sequences, DFT of complex conjugate sequence, multiplication of two DFTs- the circular convolution, Parseval's theorem, circular correlation, Digital linear filtering using DFT. Signal segmentation , overlap-save and overlap-add method.

Module-3

Fast-Fourier-Transform (FFT) algorithms: Fast-Fourier-Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms)., speed improvement factor, Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and Decimation-in-frequency algorithms , calculation of DFT when N is not a power of 2.

Module-4

IIR filter design: Classification of analog filters, generation of Butterworth polynomials, frequency transformations. Design of Butterworth filters, low pass, high pass, band pass and band stop filters, Generation of Chebyshev polynomials, design of Chebyshev filters, design of Butterworth and Chebyshev filters using bilinear transformation and Impulse invariance method, representation of IIR filters using direct form one and two, series form and parallel form.

Module-5

FIR filter design: Introduction to FIR filters, symmetriv and antisymmetric FIR filters, design of linear phase FIR filters using - Rectangular, Bartlett, Hamming, Hanning and Blackman windows, design of FIR differentiators and Hilbert transformers, FIR filter design using frequency sampling Technique. Representation of FIR filters using direct form and lattice structure.

5.0 Relevance to future subjects

Sl.no	Semester	Subject	Topics
01	VIII	Project work	Digital image processing, communication system and wireless network, VlSI system design and architecture, Biomedical image processing, control system and robotics

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Audio engineering and consumer electronics
02	Telecommunication and networking
03	Medical Imaging and healthcare
04	Industrial automation and predictive maintenance and defense system

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL	Topic: DSP Processors

8.0 Books Used and Recommended to Students

Text Books

1. Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson, 1st Edition, 2016.
2. Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.

Reference Books

1. Digital Signal Processing – Principles, Algorithms, and Applications, Jhon G. Proakis, Dimitris G. ManolakisPearson 4th Edition, 2007.
2. Digital Signal Processing A.NagoorKani McGraw Hill, 2nd Edition, 2012.
3. Digital Signal Processing, Shaila D. Apte, Wiley ,2nd Edition, 2009,
4. Digital Signal Processing, Ashok Amberdar, Cengage, 1stEdition, 2007
5. Digital Signal Processing Tarun Kumar Rawat Oxford 1st Edition, 2015
6. Signals and Systems, NagoorKani , McGraw Hill, 1st Edition 2010
7. Signals and Systems, A Primer with MATLAB Matthew N.O. Sadiku Warsame H.Ali CRC Press 1st Edition
8. Signals and Systems, Anand Kumar, PHI, 3rd Edition, 2015.

Additional Study material & e-Books

1) P.Ramesh Babu"Digital Signal Processing", Sitech publication 2003
2) "Digital Signal Processing" A Simplified approach by Dr. D Ganesh Rao & V P Gejji

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

Website and Internet Contents References

1) https://www.tutorialspoint.com/digital_signal_processing/index.html
2) www.bores.com/courses/intro/basics/1_whatis.html

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Elsvier Journal	https://www.journals.elsevier.com/digital-signal-processing/
2	ICGST Journal of Digital signal processing	http://www.icgst.com/journals/journal.aspx?subid=45
3	International Journal of Advancements in Digital SignalProcessing	http://journals.theired.org/ijdsp.html
4	Science Direct	http://www.sciencedirect.com/science/journal/10512004

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student 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.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means 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.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.

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1.	Signals, systems and signal processing, Elementary signals-	20
	2.	Classification of signals, Basic Operations on signals	
	3.	Properties of system, concept of frequency in continuous and Discrete time signals,	
	4.	sampling of analog signals, the sampling theorem, quantization of continuous amplitude and sinusoidal signals	
	5.	coding of quantized samples, digital to analog conversion,	
	6.	Introduction and convolution sum	
	7.	Convolution sum and convolution integral	
	8.	Properties of Impulse response I , solution of difference equations.	
2	9.	Introduction to DFT, definition of DFT and its inverse, matrix relation to find DFT and IDFT	20
	10.	Properties of DFT linearity, circular time shift, circular frequency shift, circular folding,	
	11.	symmetry of real valued sequences, real even and odd sequences, DFT of complex conjugate sequence	
	12.	circular convolution – periodic convolution Use of tabular arrays, circular arrays	
	13.	Stock ham's methods- Examples	
	14.	linear convolution – two finite duration sequence	

	15.	overlap add methods with examples	
	16.	overlap save methods with examples	
3	17.	Introduction to Fast Fourier Transform algorithms	20
	18.	Decimation in time algorithm with examples	
	19.	Examples	
	20.	first decomposition, number of computations	
	21.	continuation of decomposition, number of multiplications	
	22.	computational efficiency with examples	
	23.	decimation in frequency algorithms with example	
	24.	Inverse radix-2 algorithm.	
4	25.	Characteristics of commonly used analog filters – Butterworth	20
	26.	Characteristics of commonly used analog filters Chebyshev Type - I filters.	
	27.	Analog to analog frequency transformations.	
	28.	Design of Digital IIR filters from analog filters (Butterworth impulse invariance method)	
	29.	Design of Digital IIR filters from analog filters (Chebyshev impulse invariance method)	
	30.	Design of Digital IIR filters from analog filters (Butterworth bilinear transformation)	
	31.	Design of Digital IIR filters from analog filters (Chebyshev bilinear transformation)	
	32.	representation of IIR filters using direct form one and two, series form and parallel form	
5	33.	Introduction to FIR filters. symmetriv and antisymmetric FIR filters	20
	34.	Design of FIR filters using – Hamming,	
	35.	Design of FIR filters using – Hanning	
	36.	Design of FIR filters using –rectangular	
	37.	Design of FIR filters using Bartlett	
	38.	Design of FIR filters using Blackman	
	39.	FIR filter design using frequency sampling Technique.	
	40.	FIRfilters-direct form, cascade and Linear Phase Form	

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 Understand Time-domain representations for LTI systems ,Discrete fourier transform, DIF and DIT-FFTalgorithms , IIR filter design & FIR filter design	All Modules of the syllabus	4	Individual Activity.	Book 1, 2 of the text book
3	Quiz:	Students study the Time-domain representations for LTI systems ,Discrete fourier transform, DIF and DIT-FFTalgorithms , IIR filter design & FIR filter design	All Modules of the syllabus	9	Individual Activity.	Book 1, 2 of the text book.

14.0 QUESTION BANK

Module 1: Introduction & Time-domain representations for LTI systems

1. Define a signal and a system. Explain any five properties of a LTI system.
2. For each of the systems state whether system is linear, shift invariant, stable, causal, and invertible.
   i) $y(n) = \log x(n)$
   ii) $y(n) = x(n^3)$
3. Check whether the fallowing signals are periodic or not. If periodic, determine their fundamental period.
   i) $x(n) = \cos(\prod n/7)\sin(\prod n/3)$
   ii) $x(t) = (2\cos^2(\prod t/2)-1)\sin(\prod t).\cos(\prod t)$
4. A rectangular pulse $x(t) = A \quad 0 \le t \le T$
   $= 0$ elsewhere
   is applied in an integrator circuit. Find total energy of the output y(t) of the integrator.
5. Sketch the fallowing signals and determine their even and odd components and
   i) r(t+2)-r(t+1)-r(t-2)+r(t-3) ii) u(n+2)-3u(n-1)+2u(n-5)
6. Find the periodicity the signal $x[n] = \cos[2\prod n/5] + \cos[2\prod n/7]$
7. The impulse response of a LTI system is given by h[n] = {1,2,1,-1}, Determine the response of the system for the inputand x[n] = {1,2,3,1} and sketch the output.
8. Find the convolution of two finite duration sequences $h[n]=a^n u[n]$ for all n
   $x[n] = b^n u[n]$ for all n i)a=b ii)a≠b.
9. Find the step response of a system whose impulse response is given by h(t) =u(t+1)-u(t-1)
10. Determine y[n] if x[n]=n+2 for $0 \le n \le 3$ and $h[n] = a^n u[n]$ for all n
11. What do you mean by impulse response of an LTI system? How can the above be interpreted? Starting fromfundamentals deduce the equation for the response of an LTI system if the input sequence x(n) and the impulse response are given.
12. Determine the response of LTI system whose input and unit sample response is given as $x(n) = n+1$ for $0 < n < 2$
    0 else
    $h(n) = a^n u(n)$ for all n.

Module 2: Discrete Fourier Transforms

1) State and prove time shifting property of DFT.
2) Explain how the DFT can be used to compute N equispaced samples of the Z-transform of an N-point Sequence, on a circle of radius r.
3) Using Overlap-save method compute y (n) of a FIR filter with impulse response h (n) = {3, 2, 1} and input x(n)={2,1,-1,-2,-3,5,6,-1,2,0,2,1}.Use only 8 point circular convolution in your approach.
4) Compute circular convolution of two given sequences $x_1(n)=(2,1,2,1)$,$x_2(n)=(1,2,3,4)$using DFTand IDFT method.
5) For the given sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$. Find $x_3(n)$ = such that X3(k) = $X_1(k).X_2(k)$.
6) Find $x_3(n)$ using DFT and IDFT method for the given $x_1(n) = \{1,1,2,1\}$, $x_2(n) = \{1,2,3,4\}$
7) Consider sequence $x_1(n) = \{0,1,2,3,4\}$,$x_2(n) = \{0,1,0,0,0\}$.Determine a sequence y(n) so that$Y(k) = X_1(k) . X_2(k)$
8) Find the 4 point circular convolution of the sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$ using thetime domain approach and verify the result using frequency domain approach**.**
9) Compute the 4 point DFT of the sequence $x(n) = \{1,0,1,0\}$.Also find y(n) if $Y(k) = X((k-2))_4$
10) Consider the sequence x1(n)= {0,1,2,3,4},x2(n) ={0,1,0,0,0},s(n)={1,0,0,0,0} and their point DFT's
    i) Determine a sequence y(n) so that y(k)=x1(k).x2(k)
    ii) Is there a sequence x3(n) such that s(k)=x1(k).x2(k)?
11) A long sequence x(n) is filtered though a filter the impulse response h(n) to yield the output y(n),if x(n) ={1,1,1,1,1,3,1,1,4,2,1,1,3,1},h(n)={1,-1}.Compute y(n) using overlap save techniques.
12) Compare linear convolution and circular convolution.
13) Compute the linear convolution of the sequences x1(n)={1,2,3,1} and x2(n)= {4,3,2,2} usingcircular convolution.
14) Define DFT. Derive the relationship of FT to i) the DTFT ii) the z transform.

A long sequence x(n) is filtered through a filter with impulse response h(n) to yield the output y(n). If h(n)=(1,2), x(n) =(1,4,3,0,7,4,-7,-7,-1,3,4,3), compute y(n), using the Overlap-add method. Use onlya 5- point circular convolution.

15) Find DFT of a sequence x(n) = (1,1,0,0) and also find IDFT of Y(k) = (1,0,1,0).
16) State and Prove the Periodicity and Linearity property of DFT.
17) The two sequences $x_1(n)$ and $x_2(n)$ are given as follows $x_1(n)$ =(2,1,2,1) and $x_2(n)$ = (1,2,3,4). Findout sequence $x_3(n)$ which is equal to circular convolution of above two sequences $x_3(n) = x_1(n) \text{O} x_2(n)$. and verify the result using matrix multiplication method.
18) State and Prove Parseval's Theorem.
19) If x(n) = X(k) then show that DFT$[x((-n))_N] = X((-k))_N$
20) For the given sequence $x_1(n)$ = {1,2,3,1},$x_2(n)$ = {4,3,2,2}. Find $x_3(n)$ = such that$X_3(k) = X_1(k).X_2(k)$
21) Compute the 4 point DFT of the sequence x(n) = {1,0,1,0}.Also find y(n) if $Y(k) = X((k-2))_4$
22) Find the 4 point circular convolution of the sequence $x_1(n)$ = {1,2,3,1},$x_2(n)$ = {4,3,2,2} using the time domain approach and verify the result using frequency domain approach.
23) Compute IDFT of the sequence X(k) = (2,1+j,0,1-j)
24) For the given sequence $x_1(n)$ = {1,1,1,1},$x_2(n)$ = {2,2,2,2}. Find $x_3(n)$ = such that$X_3(k) = X_1(k).X_2(k)$.

Module 3: Fast Fourier transform algorithm

1) What are the properties of phase factor (W_N) that are exploited in fast fourier transform algorithms?
2) Develop decimation in time (DIT) FFT algorithm with all necessary steps and neat signal flow diagram for N-point DFT.
3) What is FFT? Explain Radix-2 DIT-FFT algorithm.
4) Develop DIF-FFT algorithm with all necessary steps and neat signal flow diagram used in computing N- point DFT, X(k) of a N-point sequence x(n).Using the same. Compute the DFT sequence x(n)={1,1,1,1,1,1,1,1}.
5) Derive Radix-2 DIF FFT algorithm to compute DFT of a N=8 point sequence and draw the complete signal flow graph.
6) Find the sequence x(n) corresponding to the 8 point DFT X(k)={4,1-j2.414,0,1-j0.414,0,1+j0.414,01+j2.414} by using any of the Radix-2 FFT algorithms to compute IDFT.
7) Determine 4 point IDFT of X(k)={2.5,-0.25+j0.75,0,-0.25-j0.75} using DIFFFT algorithm.
8) How many complex multiplications are required for direct computation of 64 point DFT? What is its value if FFT is used?
9) Determine 8 point DFT of x(n) = {1,0,-1,2,1,1,0,2} using radix-2 DIT-FFT algorithm. Show clearlyall the Intermediate results.
10) Why FFT is needed? What is the speed improvement factor in calculating 64 point DFT of a sequence using direct computation and FFT algorithm.
11) What are the differences and similarities between DIT and DIF FFT algorithm?
12) Develop DIT FFT algorithm for decomposing the DFT for N=6 and draw the flow diagrams for N= 2x3.
13) If x1(n) =[1,2,0,1] and x2(n) = [1,3,3,1], Obtain x1(n)©x2(n) using DIT-FFT algorithm.
14) Find the 4 point DFT of the following sequences, using a single 4 point DFT x1(n) =[1,2,0,1] and x2(n)= [2,2,1,1].
15) Compute number of complex multiplications for the direct evaluation of DFT v/s FFT algorithm forN=4,16,64,256 also find the speed improvement factor.
16) Find the 8 point DFT of the given sequence x(n). X(n)=(0,1,2,3,4,5,6,7)
17) Compute 8 point DFT of the sequence x(n)=(11111111) using DIT, DIF algorithm.
18) Compute IDFT of the sequence X(k)={4,1-j2.414,0,1-j0.414,0,1+j0.414,0,1+j2.414}
19) Determine 8 point DFT of x(n) = {1,0,-1,2,1,1,0,2} using radix-2 DIT-FFT algorithm. Show clearly all the intermediate results.
20) Find the DFT of a sequence x(n)={1,2,3,4,4,3,2,1} using DIT algorithm.
21) Compute 4-point DFT of a sequence x(n)={0,1,2,3} using DIT algorithm.
22) Develop DIT-FFT algorithm for N=9=3x3 and draw the complete signal flow graph. A 9 point real valued sequence is given by x(n)={0,1/4,1/2,3/4,1,3/4,1/2,1/4,0}

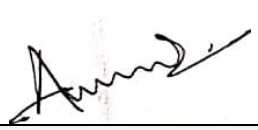
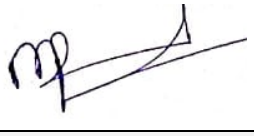
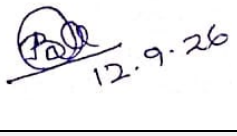
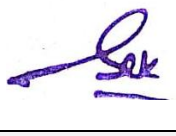
23) Find the DFT of a sequence x(n)={1,1,1,1,1,1,1,1} using DIT algorithm.

Module 4: Design of IIR Digital filters

1) Transform the analog filter H(s) = (s+3)/(S+1)(s+2) to a digital filter using the matched z transform. Let T=0.5 sec.
2) Using the bilinear transformation S= $(1- z^{-1})/ (1+z^{-1})$ .What is the image of $S=e^{j\square /2}$in the Z-plane.
3) Determine the order of Butterworth and Chebyshev approximation analog filters used to meet the following specification: passband attenuation of 1dB at 4kHz and stop band attenuation of 40B at 6 kHz.
4) Design a chebyshev type I analog filter to meet the following specification: pass band attenuation2 dB at 4 rad/sec and stop band attenuation of 10 dB at 7 rad/sec.
5) Write a short note on bilinear transformation.
6) Compare FIR versus IIR filters.
7) Design a analog filter which has equiripple characteristics in passband minitoni8c falloff characteristics in stop band given maximum passband attenuation of 2.5dB at Ωp= 20 rad/sec and the stop band attenuation of 30 dB at Ωs =30 rad/sec. Transform the analog filter to digital filter using impulse invariance method.
8) Transform the analog filter $H(s) = (s+0.1)^2/(s+0.1)^2+9$ to H(Z) using the impulse invariance transformation.
9) For the analog transfer function H(s)=(2)/((s+1)(s+2)). Determine H(z) using impulse invariance method. Assume T=1 sec.
10) Using Bilinear transformation, design a high pass filter, monotonic in passband with cutoff frequency of 1000 Hz at α_P=3 dB and down to 10 dB at 350 Hz. The sampling frequency is 5000 Hz.
11) Determine direct form II realization for the following system y(n)=-0.1y(n-1)+0.72y(n-2)+0.7x(n)-0.252x(n-2).
12) Realize the system with difference equation y(n)=3/4y(n-1)-1/8y(n-2)+x(n)+ 1/3x(n-1) in cascade form.
14) Obtain the direct form I, direct form II, cascade and parallel form realization for the following system y(n)= -0.1y(n-1)+0.2 y(n-2)+3x(n)+3.6x(n-1)+0.6x(n-2).
13) Draw the direct form II, cascade and parallel form structure for the following system
$H(z)= (1-3/4z^{-1}+1/8z^{-1})/(1+z^{-1}+2/9z^{-2})(1+1/4z^{-1})$
14) Obtain a parallel realization for the following
$H(z)= (8z^3-4z^{-2}+11z-2)/(z-1/4)(z^{-2}-z+1/2)$

Module 5: Design of FIR Digital filters

1) Show that if the impulse response has the even symmetry then FIR filter possesses linear phase Characteristics. Comment on position of zero on the Z-plane
2) Explain the frequency sampling method of designing FIR filters and draw the corresponding block diagram
3) Explain the structures used for realizing FIR filters by illustrations.
4) Show that the roots of H(z) occur in reciprocal pair for a linear phase FIR filter.
5) Consider a FIR filter with system function:
$H(z) = 1+2.82 z^{-1}+3.4048 z^{-2} +1.74 z^{-3.}$ Sketch the direct form and lattice realization of the filter.
6) Write a short note on window-based Fir filter design.
7) Write short notes on Butterfly operation and in place computation.
8) What are advantages and disadvantages ith design of FIR filters using window function?
9) The frequency response of a linear phase Fir filter is given by
$H(e^{jw}) = e^{j3w}[2+1.8 co 3w+1.2 cos2w+0.5cosw]$.Find the impulse response sequence of the filter.
10) What condition on the Fir sequence h(n) are to be imposed in order that the filter can be called a linear phase filter.
11) Discuss design method of FIR filters

Prepared by	Checked by		
		 12.9.26	
Prof.A.U.Neshti	**Dr . M. P. Yenagimath**	**HOD**	**Principal**

Subject Title	**POWER ELECTRONICS**		
Subject Code	BEE503	**CIE Marks**	50
Number of Lecture Hrs / Week	04	**SEE Marks**	50
Total Number of Lecture Hrs	50	**Exam Hours**	03
			CREDITS-4

FACULTY DETAILS:		
Name: Prof. S. D. Hirekodi	**Designation:** Asst. Professor	**Experience:**26 Years
No. of times course taught: 04	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical and Electronics Engineering	III	Electric Circuit Analysis
03	Electrical and Electronics Engineering	III	Analog Electronic Circuit

2.0 Course Objectives

- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and limitations.
- To explain different types of thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

3.0 Course Outcomes

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

	Course Outcome	**RBTL**	**POs**
C303.1	Explain application areas of power electronics, types of power electronic circuits and switches and characteristics of power diodes and operation of diode rectifiers with R and RL load.	L_1.L_3	1,2,3,6,8,9,10,12
C 303.2	Explain steady state, switching characteristics and gate /base drive requirements of different power transistors.	L_1-L_4	1,2,3,6,8,9,10,12
C303.3	Discuss different types of thyristors, their operation, characteristics and firing circuit.	L_1-L_4	1,2,3,6,8,9,10,12
C303.4	Discuss the principle of operation and analysis of controlled rectifiers and AC voltage controllers.	L_1-L_4	1,2,3,6,8,9,10,12
C303.5	Discuss the principle of operation and analysis of DC – DC and DC –AC converters.	L_1-L_4	1,2,3,6,8,9,10,12
Total Hours of instruction		**50**	

4.0 Course Content

Module-1
Introduction: Applications of Power Electronics, Ideal Characteristics of switches, Characteristics of practical devices; Specifications of Switches, control characteristics of power devices, Types of Power Electronic Circuits, Peripheral Effects, Intelligent Modules.
Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes, Freewheeling diodes with RL load.
Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase FullWave Rectifiers with R load, Single-Phase Full-Wave Rectifier with RL Load.

Module-2
Power Transistors: Introduction, Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, Power MOSFETs – Steady State Characteristics, Switching Characteristics, IGBTs; BJT Base Drive, MOSFET Gate Drive, Isolation of Gate and Base Drives, Pulse transformers and Optocouplers.

Module-3
Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn- On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, Thyristor Firing Circuits, Unijunction Transistor.

Module-4
Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase duel Converters.
AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three Phase Full-Wave Controllers.

Module-5
DC-DC Converters: Introduction, principle of step down chopper with R and RL load; principle of step up chopper with R load, Control strategies, performance parameters, DC-DC converter classification.
DC-AC Converters: Introduction, principle of operation single phase bridge inverters, performance parameters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Industrial Drives and Applications	Motor drives and their control
02	VII	FACTS and HVDC Transmission	Control and analysis of FACTS and HVDC converters

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Industrial drive control, Electrical vehicles,UPS and SMPS
02	Inverters used for domestic and commercial purpose
03	Rectifier and inverter stations used in FACTS and HVDC transmission system.
04	Space and defence fields.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical Assignment	Practical assignments to be given to the students based on real time problems to design converters as per the requirement.

8.0 Books Used and Recommended to Students

Text Books
1.Power Electronics: Circuits Devices and Applications, Mohammad H Rashid,4th Edition, 2014 .
Reference Books
1. Power Electronics, P.S. Bimbhra, Khanna Publishers, 5th Edition, 2012 2.Power Electronics: Converters, Applications and Design, Ned Mohan at el, 3rd Edition, 2014. 2. Power Electronics, Daniel W Hart, 1st Edition, 2011. 3. Elements of Power Electronics, Philip T Krein, Indian Edition, 2008.
Additional Study material & e-Books
1. Power Electronics, J. S. Chitode

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

Website and Internet Contents References
*1) www.rejinpaul.com/.../vtu-**eee-notes***
2) https://www.vssut.ac.in/lecture_notes/lecture1424354515.pdf
3) www.vtuupdates.com
4) *www.nptelvideos.in/2012/11/power-electronics.html*

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of Power Electronics and Drives Systems	***iaesjournal.com/online/index.php/IJPEDS***
2	Journal of Power Electronics	***www.jpe.or.kr/***
3	IEEE Transactions on Power Electronics	***ieeexplore.ieee.org/***

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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- Three tests will be conducted for 25 marks and average of best two IA will be considered for CIE 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. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks) .Group discussion/Seminar/online quiz any one of three suitably planned to attain the COs and POs for 25 Marks (duration 01 hours)
- **The sum of best two tests and two assignments will be out of 100 marks and will be scaled down to 50 marks.**

Semester-End Examination:

- Theory SEE will be conducted by University as per the scheduled time table, 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 No.	Lecture No.	Content of Lecture	% of Portion
I	1.	Introduction: Applications of Power Electronics Ideal Characteristics of switches, Characteristics of practical devices	20
	2.	Specifications of Switches, control characteristics of power devices,	
	3.	Types of Power Electronic Circuits, Peripheral Effects, Intelligent modules.	
	4.	Power Diodes: Introduction, Diode Characteristics	
	5.	Reverse Recovery Characteristics, Power Diode Types,	
	6.	Silicon Carbide Diodes, Silicon Carbide Schottky Diodes	
	7.	Freewheeling Diodes , Freewheeling Diodes with RL Load,	
	8.	Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load,	
	9.	Single-Phase Full-Wave Rectifier with R Load	
	10.	Single-Phase Full-Wave Rectifier with RL Load	
II	11.	Bipolar Junction Transistors – Steady State Characteristics	20
	12.	Switching Characteristics of BJT	
	13.	Switching Limits of BJT	
	14.	Power MOSFETs – Steady State Characteristics	
	15.	Power MOSFETs –Switching Characteristics	
	16.	IGBTs : Introduction	
	17.	BJT Base Drive	
	18.	Gate Drives for IGBTs, MOSFETs	
	19.	Isolation of Gate and Base Drives	
	20.	Pulse Transformers and Opto-Couplers	
III	21.	Thyristors: Introduction, Thyristor Characteristics	20
	22.	Two-Transistor Model of Thyristor	
	23.	Thyristor Turn- On, Thyristor Turn-Off process	
	24.	A brief study on Thyristor Types	
	25.	Series Operation of Thyristors	
	26.	Parallel Operation of Thyristors	
	27.	di/dt Protection	
	28.	dv/dt Protection	
	29.	Thyristor Firing Circuits	
	30.	Unijunction Transistor	
IV	31.	**Controlled Rectifiers:** Introduction, Single phase half wave circuit with RL Load.	20
	32.	Single phase half wave circuit with RL Load with freewheeling diode	
	33.	Single phase half wave circuit with RLE Load	
	34.	Single-Phase Full Converters with RLE Load	
	35.	Single phase dual converter, Principle of operation of Three- Phase dual Converters	
	36.	**AC Voltage Controllers:** Introduction, Principle of phase control & Integral cycle control	

	37.	Principle of Integral cycle control	
	38.	Single-Phase Full-Wave Controllers with Resistive Loads,	
	39.	Single-Phase Full-Wave Controllers with Inductive Loads	
	40.	Three-Phase Full-Wave Controllers	
V	41.	**DC-DC Converters:** Introduction	
	42.	Principle of step down and step up chopper with RL load	**20**
	43.	Performance parameters	
	44.	DC-DC converter classification	
	45.	**DC–AC Converters:** Introduction	
	46.	Principle of Operation of Single-Phase Bridge Inverters	
	47.	Three-Phase Inverters	
	48.	Voltage Control of Single-Phase Inverters	
	49.	Harmonic Reduction	
	50.	Current-Source Inverters	

13.0 Assignments

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 and POs.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1, 2 & 3 of the syllabus	9	Individual Submission in the standard format is expected	Book 1, 2 of the textbooks list.
2	Assignment 2: On line quiz covering all modules to attain COs and POs	Students study all Topics and appear for on line quiz to enhance subject knowledge.	Module 1-5 of the syllabus	12	Individual Submission through on line Google link.	Book 1,2 and 3 of the textbooks list.

14.0 QUESTION BANK

Module I

Module II

1 Draw and briefly explain the V-I characteristics of B.J.T.
2 Describe the switching characteristics of a BJT with the help of its equivalent circuit and wave diagrams.
3 Describe the input and output characteristics for a B.J.T. Show the region of the transistor characteristics where it acts like a switch.
4 Define the following terms with respect to Transistor switch.
a)Over drive factor b)Forced β
5 With a circuit diagram, explain 'anti saturation control' of BJT.
6 What the different types of base drive control circuits are as applied to power transistor? Explain any one in detail.
7 With a circuit diagram, explain 'proportional base drive control' of power transistor.
8 Explain the constructional details and working of n-channel enhancement type MOSFET.
9 Draw and briefly explain the transfer and drain characteristics of MOSFET.
10 Explain the constructional details and working of n-channel depletion type MOSFET.
11 Compare power MOSFETs with BJTs.
12 Draw and explain the switching characteristics of power MOSFET.
13 State the merits, limitations and area of application of the IGBT power switching devices.
14 With neat sketches, explain the switching characteristics of IGBT.
15 Give the structure, static characteristics and its applications of the device: IGBT.
16 Explain the typical gate drive circuit for MOSFET.
17 Discuss methods for providing isolation of gate/base circuits from power circuit, with circuit diagrams.
18 What is di/dt and dv/dt? How devises are protected against di/dt and dv/dt?

Module III

1. Describe the different modes of operation of a thyristor, with the help of its static V-I characteristics.
2. Explain the static characteristics of SCR and hence define i)forward break over voltage ii)Latching current and iii)Holding current
3. With the help of two transistor model for an SCR, derive the expression for anode current.
4. Distinguish between latching current and holding current of a SCR.
5. Mention the different methods of turning on of an SCR. Explain gate triggering.
6. With neat diagram, explain the turn on and turn off characteristics of SCR.
7. Distinguish between i) Converter grade and inverter grade thyristors ii) Thyristor turn off time and circuit turn off time.
8. Explain the gate characteristics of SCR with appropriate diagrams.
9. Explain the significance of di/dt and dv/dt ratings of SCR
10. Explain how snubber circuit is used for dv/dt protection of SCR.
11. Explain with the help of a circuit diagram and relevant waveforms, the principle of resistance –capacitance triggering of an SCR.
12. Explain the principle of synchronized UJT triggering of an SCR. Draw the waveforms at different points.
13. What is a controlled rectifier? How the turn off of the SCR takes place in controlled rectifiers?
14. With a circuit diagram and waveforms, explain working of a 1-phase half controlled bride rectifier. Derive the expression for the average voltage across R-L load.
15. Discuss the role of a freewheeling diode in a converter circuit.
16. Ten Thyristors are used in a string to withstand a DC voltage of V_s = 15 kV. The maximum leakage current and recovery charge differences of thyristirs are 10 mA and 150 μC respectively. Each thyristor has a voltage sharing resistance of R = 56 kΩ and capacitance of C_1 = 0.5 μF. Determine (a) the maximum steady state voltage sharing $V_{DS(max)}$ (b) the steady state voltage derating factor (c) the maximum transient voltage sharing $V_{DT(max)}$ and (d) the transient voltage derating factor
17. A string of four series connected thyristors is provided with static and dynamic equalizing circuits. This string has to withstand an off state voltage of 10 kV. The static equalizing resistance is 25000 Ω and the dynamic equalizing circuit has R_c = 40 Ω and C = 0.08 μF. The leakage currents for four thyristors are 21 mA, 25 mA, 18 mA and 16 mA respectively. Find the voltage across each SCR in off state and the discharge current of each capacitor at the time of turn on.
18. It is required to operate 250 A SCR in parallel with 350 A SCR with their respective on state voltage drops of 1.6 V and 1.2 V. calculate the value of resistance to be inserted in series with each SCR so that they share the total load of 600 A in proportion to their current ratings.

Module IV

1. Explain the working of 1-phase, half wave controlled rectifier with R-L load. What will be the effect of connecting freewheeling diode?
2. Draw the circuit diagram and explain with waveforms, the working of 1-phase fully controlled bride rectifier with R-L load. Derive the expression for the average voltage across R-L load.
3. Explain the basic principle of inversion of a 1-phase full wave converter.
4. Explain with the help of circuit diagram and relevant waveforms, the operation of 1-phase half controlled bride converter with RLE load. Also derive the expression for average value of the output voltage.
5. What are AC voltage controllers? Explain two types of AC voltage controller.
6. What is an AC voltage controller? List some of its industrial applications. Enumerate its merits and demerits.
7. Draw the circuit diagram of 1-phase AC voltage controller and explain the principle of phase control, with the help of relevant waveforms.
8. Describe the working of 1-phase AC voltage controller feeding an R-L load with the help of waveforms.
9. Draw the circuit of a single phase AC voltage controller and explain the principle of On-OFF control, with the help of relevant waveforms. Derive the expression for the RMS output voltage in terms of the RMS supply voltage and the duty cycle of operation of the controller.
10. With the help of a suitable circuit diagrams and waveforms, explain the operation of 1-phase AC regulators using on/off control.
11. For AC voltage control, discuss the difference in performance between single phase unidirectional controller and bi-directional controller foe a resistive load with circuit diagrams and output voltage waveforms.
12. Derive an expression for RMS output voltage of 1-phase full wave controller having inductive load for discontinuous current mode.
13. Explain why short duration gating pulses are not suitable for bi-directional ac voltage controllers with inductive

loads.

14 Compare the full wave and half wave AC controllers?

15 A single phase 230 V, 1 kW heater is connected across single phase, 230 V, 50 Hz supply through an SCR. For firing angle delays of 45^0 and 90^0 calculate the power absorbed in the heater element.

16 A single phase full converter bridge is connected to RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10 A is continuous over the working range. For R = 0.4 Ω and L = 2 mH, calculate

(a) Firing angle delay for E =120 V
(b) Firing angle delay for E = -120 V
Indicate which source is delivering power to load in parts (a) and (b)
(c) In case the output current is assumed constant, find the input power factor for both (a) and (b)

Module V

1 Giving neat circuit diagram and waveforms, explain the working of single phase half bridge inverter with 'R' load.

2 With circuit diagram of half bridge transistor inverter, explain the operation. Sketch waveforms of output voltage and current in devices, for a resistive load. Derive an expression for output RMS voltage.

3 Explain the performance parameters of inverters.

4 Explain single phase bridge inverter with relevant circuit diagram and waveforms. Assume an R load.

5 Explain single phase bridge inverter with relevant circuit diagram and waveforms. Assume an R-L load.

6 Explain the output voltage control of inverter by pulse width modulation

7 Write a note on voltage control of inverter by sinusoidal pulse width modulation technique.

8 Draw the circuit of a single phase, current source inverter employing power switching transistors. Explain the operation of the circuit.

9 Giving neat circuit diagram and waveforms, explain the working of single phase half bridge inverter with 'R' load.

10 With circuit diagram of half bridge transistor inverter, explain the operation. Sketch waveforms of output voltage and current in devices, for a resistive load. Derive an expression for output RMS voltage.

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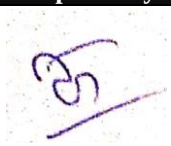		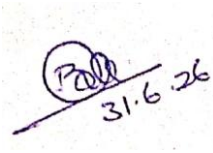	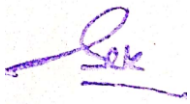
Prof. S. D. Hirekodi	**Prof. S. D. Hirekodi**	**HOD**	**Principal**

Subject Title	**POWER ELECTRONICS LABORATORY**		
Subject Code	BEEL504	**CIE Marks**	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	**SEE Marks**	50
Credit	01	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. S.D.Hirekodi	**Designation:** Asst.Professor	**Experience:** 26 Years
No. of times course taught:03	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical and Electronics Engineering	III	Electric Circuit Analysis
03	Electrical and Electronics Engineering	III	Analog Electronic Circuit
04	Electrical and Electronics Engineering	IV	Electric motors

2.0 Course Objectives

- To conduct experiments on semiconductor devices to obtain their static characteristics.
- To study different methods of triggering the SCR
- To study the performance of single phase controlled full wave rectifier and AC voltage Controller with R and RL loads.
- To control the speed of a DC motor, universal motor and stepper motors.
- To study single phase full bridge inverter connected to resistive load.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to

CO	Course Outcome	RBT Level	POs
C304.1	Analyze the static characteristics of semiconductor devices to discuss their performance.	L4	1,2,3,8, 9,10,12
C304.2	Experiment with different methods of triggering the SCR.	L3	1,2,3,8, 9,10,12
C304.3	Analyze the performance of single phase controlled full wave rectifier and AC voltage controller with different types of load conditions.	L4	1,2,3,8, 9,10,12
C304.4	Determine the speed control of a stepper motor, universal motor and DC motors using different types of converter.	L4	1,2,3,8, 9,10,12
C304.5	Experiment with single phase MOSFET/IGBT based PWM inverter.	L3	1,2,3,8, 9,10,12

4.0 Course Content

Sl. No.	Experiments
1	Static Characteristics of SCR.
2	Static Characteristics of MOSFET and IGBT.
3	Characteristic of TRIAC.
4	SCR turn on circuit using synchronized UJT relaxation oscillator.
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode.
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8	Speed control of DC motor using single semi converter.
9	Speed control of stepper motor.
10	Speed control of universal motor using ac voltage regulator.
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12	Single phase MOSFET/IGBT based PWM inverter.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI, VII &VIII	Project work	Use of Power semiconductor devices, power converters for different applications

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Industrial drive control, Electrical vehicles, UPS and SMPS
02	Inverters used for domestic and commercial purpose
03	Rectifier and inverter stations used in HVDC transmission system.

7.0 Books Used and Recommended to Students

Text Books
1. Power Electronics: Circuits Devices and Applications, Mohammad H Rashid,4th Edition, 2014 .
Reference Books
1. Power Electronics: Converters, Applications and Design, Ned Mohan at el, 3rd Edition, 2014. 2. Power Electronics, Daniel W Hart, 1st Edition, 2011. 3. Elements of Power Electronics, Philip T Krein, Indian Edition, 2008.

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

Website and Internet Contents References
1) www.rejinpaul.com/.../vtu-**eee**-**notes**
2) https://www.vssut.ac.in/lecture_notes/lecture1424354515.pdf
3) www.vtuupdates.com
4) www.nptelvideos.in/2012/11/power-electronics.html

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	International Journal of Power Electronics and Drives Systems	**iaesjournal.com/online/index.php/IJPEDS**
2	Journal of Power Electronics	**www.jpe.or.kr/**
3	IEEE Transactions on Power Electronics	**ieeexplore.ieee.org/**

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):
CIE marks for the practical course is 50 Marks
The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment to be evaluated for conduction with observation sheet t and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The average of 02 tests is scaled down to 20 marks (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):
SEE marks for the practical course is 50 Marks
General rubrics suggested for SEE are, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks .Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours.

11.0 Course Delivery Plan

Expt. No	Name of the Experiment	% of Portion
1	Static Characteristics of SCR.	8.33
2	Static Characteristics of MOSFET and IGBT.	8.33
3	Characteristic of TRIAC.	8.33
4	SCR turn on circuit using synchronized UJT relaxation oscillator.	8.33
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.	8.33
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode.	8.33
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.	8.33
8	Speed control of DC motor using single semi converter.	8.33
9	Speed control of stepper motor.	8.33
10	Speed control of universal motor using ac voltage regulator.	8.33
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.	8.33
12	Single phase MOSFET/IGBT based PWM inverter.	8.33

12.0 QUESTION BANK

1. Sketch the V-I characteristics of an SCR without gate current and with gate current.
2. What is the advantage of SCR over power Transistor?
3. What is the constructional difference in an inverter Thyristor and converter grade Thyristor?
4. List the methods of turning ON of SCR.
5. Define latching current, Holding current, Break over voltage. Show these on the V-I characteristics of SCR.
6. What is the turn-on time of a Thyristor?
7. What is the turn-off time of a Thyristor?
8. Why is SCR called as latching device?
9. Why pulse triggering of SCR is preferred over single or DC triggering?
10. List the important ratings of SCR.
11. What purpose a resistor in series with gate serves?
12. Sketch the characteristics of Triac.
13. What are the terminals of Triac?
14. Explain the operation of Triac in different modes.
15. In which modes is the Triac more sensitive?
16. What are the applications of Triac?
17. What is a MOSFET?
18. What are the types of MOSFET?

19. What are the differences between enhancement type and depletion type MOSFET?
20. What is pinch-off voltage of MOSFETs?
21. What is threshold voltage of MOSFET?
22. What are the transfer characteristics of MOSFET?
23. What are the output characteristics of MOSFET?
24. Why do the MOSFETs not require negative gate voltage during turn-off?
25. What is the turn-on time of a MOSFETs and IGBTs?
26. What is the turn-off time of a MOSFETs and IGBTs?
27. What do you mean by commutation?
28. Distinguish between natural commutation and forced commutation.
29. How are the forced turn-off methods classified?
30. State the conditions under which a load carrying SCR can be successfully commutated.
31. What are the purposes of commutation circuit?
32. What is forced commutation?
33. What are the different methods of commutation schemes?
34. What is DC chopper?
35. What is pulse width modulation control of a chopper?
36. What is frequency modulation control of a chopper?
37. What do you mean by auxiliary commutation?
38. What do you mean by permanent magnet stepper motor?
39. What do you mean by half step and full step motor?
40. What are applications of stepper motor?
41. What are various means of speed control of a induction motor?
42. What is a duty cycle?
43. What is the purpose of a converter in dc drives?
44. What are the parameters to be varied for speed control of separately excited dc motors?
45. What do you mean by line commutation?
46. What are the advantages of UJT triggering circuit?
47. What is a converter?
48. What is the principle of ac-dc conversion?
49. What are the performance parameters of rectifier?
50. What is the difference between a half controlled and fully controlled converter?
51. In a fully controlled single phase bridge, why does negative part of the input voltage cycle appear across Load, if load is inductive but not with resistive load.

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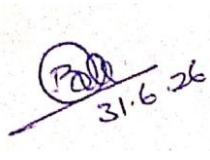
			
Prof. S. D. Hirekodi	**Prof. S. D. Hirekodi**	**HOD**	**Principal**

Subject Title	**HIGH VOLTAGE ENGINEERING**		
Subject Code	BEE515A	**CIE Marks**	50
Number of Lecture Hrs / Week	03	**SEE Marks**	50
Credits	03	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof.O. B. Heddurshetti	**Designation:** Asst. Professor	**Experience:** 20 years
No. of times course taught: 07	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical and Electronics Engineering	III	Electrical Measurements and Instrumentation
03	Electrical and Electronics Engineering	III	Transformers and Generators
04	Electrical and Electronics Engineering	IV	Transmission and Distribution

2.0 Course Objectives

- To understand the conduction and breakdown mechanism in gases, liquid and solid dielectrics.
- To know about the generation of high voltages and currents and their measurement.
- To understand the various types of over voltages phenomena and protection methods.
- To discuss non-destructive testing of materials and electric apparatus.
- To discuss high-voltage testing of electrical equipment

3.0 Course Outcomes

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

	Course Outcome	RBT level	POs
C305.1	Explain conduction and breakdown phenomenon in gases, liquid and solid dielectrics.	L2	1,2,3,8,12
C305.2	Illustrate various techniques of generation of different forms of high voltages and currents.	L3	1,2,3,8,12
C305.3	Analyze measurement techniques for high voltages and currents.	L4	1,2,3,8,12
C305.4	Explain overvoltage phenomenon and protection of electric power systems	L2	1,2,3,8,12
C305.5	Explain non-destructive testing of materials and electric apparatus and high-voltage testing of electric apparatus.	L2	1,2,3,8,12

4.0 Course Content

Module-1

Introduction: Electric field stress, gas, liquid, solid and composite dielectrics.

Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process – types of collision, Mobility of ions and electrons. Ionization Processes- Ionization by collision. Townsend's Current Growth Equation--Current Growth in the Presence of primary and Secondary Processes, Townsend's Criterion for Breakdown, Breakdown in Electronegative Gases, Time Lags for Breakdown, Paschen's Law, Corona Discharges.

Conduction and Breakdown in Liquid Dielectrics: purification of liquid dielectrics, Breakdown in Liquid dielectrics. - Suspended particle, bubble and stressed oil volume mechanism.

Conduction and Breakdown in Solid Dielectrics: Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.

Module-2

Generation of High Direct Current Voltages: Voltage Doubler circuit, Voltage multiplier circuit-Cockcroft Walton circuit, Ripple and voltage drop in multiplier circuit. Vandegraaffgenerator.

Generation of High Alternating Voltages: Cascade transformers, Resonant transformers, Tesla coil.

Generation of Impulse Voltages and currents: Standard impulse wave, Circuit for producing impulse waves- Analysis of impulse generator RLC circuit, Wave shape control, Marx circuit , Generation of impulse current: standard impulse current wave ,Circuit for producing impulse current wave.

Module-3

Measurement of High DC Voltages and Currents: Measurement of High DC Voltages – Series Resistance micro ammeter, Resistance potential divider, Generating voltmeter.

Measurement of High AC voltages- Series impedance voltmeter, Series capacitance voltmeter, Capacitance potential dividers, Capacitance voltage transformers. Electrostatic voltmeter, series capacitance peak voltmeter (chubb-Fortscue method), Spark gaps for measurement of High dc, ac and Impulse voltages - Spark gap measurements, Factors influencing the spark over voltage of sphere gaps.

Measurement of Impulse Voltages – Resistance potential dividers, capacitance voltage dividers, Mixed R-C potential dividers Peak reading voltmeters for impulse voltages.

Measurement of High DC, AC and impulse Currents - Hall generator, Resistive shunt, Rogowski coils and Magnetic links.

Module-4

Natural Causes for Over voltages

Lightning phenomenon –Charge formation in the clouds, Mechanism of lightning strokes, Mathematical model for lighting, Over voltages due to indirect stroke.

Power frequency Overvoltage – Sudden load rejection, Ferranti effect. Control of over voltages due to switching.

Protection of transmission lines against over voltages- Using shielded or ground wires, Ground rods and counter poise wires, Surge arresters -Protector tubes, Nonlinear element surge arrestor.

Module-5

Non-Destructive Testing of Materials and Electrical Apparatus

Power frequency measurements- Schering bridge for audio frequency, transformer ratio arm bridge. Partial discharge measurements- straight discharge detection, Balance detection.

High Voltage Testing of Electrical Apparatus-Testing of insulators, bushings, circuit breakers, cables. Testing of transformers- Impulse test, Tests on surge arrestors.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
1	VI	Medium Voltage Substation Design	Electrical equipments required for substation design
2	VII	Switchgear and Protection	Switchgear and protective devices

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Electric breakdown in gases, liquid and solid dielectrics.
02	High voltage AC, DC and impulse generation in power research laboratory for testing.
03	High voltage and current measurements in research laboratory for testing.
04	Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems.
05	Non-destructive test techniques in high voltage engineering. High voltage tests on power system apparatus and switchgear such as circuit breakers, insulators, transformers and cables in site and research laboratory.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical Assignment	Practical assignments will be given to the students to study electric breakdown in gases, liquids and solid dielectrics and generation and measurement of different forms of high voltages in laboratory and testing of high voltage power system apparatus and switchgears.
02	Power point presentation	Topic related to High voltage engineering subject.

8.0 Books Used and Recommended to Students

Text Books

1. High Voltage Engineering by M.S.Naidu and Kamaraju- 5th Edition, McGraw Hill. 2013.
2. High Voltage Engineering by C.L.Wadhwa, New Age International Private limited, 3rd Edition 2012.

Reference Books

1. High Voltage Engineering Fundamentals by E. Kuffel, W.S. Zaengl, J. KuffelNewnes 2nd Edition,2000.
2. High-Voltage Test and Measuring Techniques by Wolfgang Hauschild,EberhardLemke, Springer 1st Edition2014.
3. High Voltage Engineering by Farouk A.M. Rizk CRC Press 1st Edition2014.

Additional Study material & e-Books

1. High voltage test and measuring techniques: Springer
2. High voltage and electrical insulation engineering by Ravindra Arora

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

Website and Internet Contents References
• www.nptel.ac.in

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	High Voltage Engineering	http://digital-library.theiet.org/content/journals/hve 2
2	High Voltage Engineering	https://archive.nptel.ac.in/courses/108/104/108104048
3	IEEE Electrical Insulation engineering	http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=57

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 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 25marks. (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.

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 (total for 100marks).
- Marks scored shall be proportionally reduced to 50 marks.

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	Gases as Insulating Media, Collision Process, Ionization processes.	20%
	2	Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown.	
	3	Experimental Determination of Coefficients of α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown.	
	4	Streamer Theory of Breakdown in Gases.	
	5	Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges.	
	6	Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids.	
	7	Conduction and Breakdown in Commercial Liquids	
	8	Breakdown in Solid Dielectrics: Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.	
2	9	HV transformer, Need for cascade connection and working of transformers units connected in cascade.	20%
	10	Resonant Transformers. Tesla coil, HV DC- voltage double circuits	
	11	Voltage Multiplier circuits: Cock croft- Walton type high voltage DC set	
	12	Calculation of high voltage regulation and ripple	
	13	Optimum number of stages for minimum voltage drop.	
	14	Introduction to standard lightning and switching impulse voltages, Analysis of single stage impulse generator-expression for Output impulse voltage	
	15	Multistage impulse generator- working of Marx impulse generator, Rating of impulse generator, Components of multistage impulse generator	
	16	Generation of switching impulse voltage, Generation of high impulse current, Tripping and Control of Impulse Generators.	
3	17	Series resistance micro ammeter for HV DC measurements	20%
	18	Generating voltmeter- Principle, construction, Standard sphere gap measurements of HV AC, HV DC and impulse voltages, Factors affecting the measurements	
	19	Electrostatic voltmeter-principle, construction	
	20	Chubb and Fortescue method for HV AC measurement	
	21	Resistance potential dividers	
	22	Capacitance dividers, Mixed RC potential dividers	
	23	Measurement of High Currents – Direct, Alternating and Impulse	
	24	Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.	
4	25	Charge formation in the clouds	20%
	26	Mechanism of lightning strokes	
	27	Mathematical model for lighting	
	28	Over voltages due to indirect stroke.	
	29	Sudden load rejection, Ferranti effect.	
	30	Control of over voltages due to switching.	
	31	Using shielded or ground wires, Ground rods and counter poise wires	

	32	Surge arresters -Protector tubes, Nonlinear element surge arrestor.	
5	33	Power frequency measurements- Schering bridge for audio frequency,	20%
	34	Transformer ratio arm bridge.	
	35	Partial discharge measurements- straight discharge detection	
	36	Balance detection.	
	37	Testing of insulators, bushings.	
	38	Testing of circuit breakers, cables.	
	39	Testing of transformers- Impulse test	
	40	Tests on surge arrestors	

13.0 Assignments

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Questions on conduction and breakdown in gases, liquid and solid dielectrics, Generation of High voltages and Currents, Measurement of high voltages and currents.	Students will be able to explain breakdown theories in different dielectrics, Paschen's law, Time lags of breakdown, different techniques of high voltage AC, DC and Impulse generation and solve examples, different techniques of high voltage and current measurements and solve examples.	Module 1,2&3of the syllabus	8	Individual Activity.	Books 1 & 2 of the book list
2	Quiz: Online quiz covering all modules to attain Cos & POs	Students will be able to explain the concepts of high voltage engineering.	Module 1,2,3,4 & 5 of the syllabus	12	Individual Activity.	Books 1 & 2 of the book list

14.0 QUESTION BANK

Module 1:

1. What is ionization? Explain the different types of primary and secondary ionization processes of a gaseous insulation subjected to high voltage.
2. Explain Townsend's theory of gaseous breakdown. Derive the equations for the current growth and the Townsend's criterion for breakdown.
3. Explain in detail the streamer mechanism of breakdown in gases.
4. Explain briefly formative time lag and statistical time lag.
5. What are electronegative gas? Why the breakdown strength of these gases higher is compared to that of other gases?
6. What is Paschen's law? How do you account for the minimum voltage for breakdown under a given 'pxd' condition?

7. Briefly explain "Cavitation and Bubble theory" in the context of liquid dielectric breakdown.
8. Discuss the electrical properties that determine the dielectric performance of liquid dielectrics?
9. What is "Stressed oil volume theory" and how does it explain breakdown in large volume of commercial dielectrics?
10. Explain the different mechanisms by which breakdown occurs in solid dielectrics in practice.
11. Explain the terms dielectric strength, electric field intensity and electron negativity related to breakdown process of gases.
12. Explain thermal breakdown in solid dielectrics and how it is more significant than other breakdown mechanisms.
13. Define Townsend's first and second ionization coefficients. Explain the Townsend's criterion for breakdown.
14. Explain the various factors which deteriorate the strength of dielectric materials used in various electrical equipments.
15. Explain any two theories that explain breakdown in commercial liquid dielectrics.

Module 2:

1. Explain with diagrams, different types of rectifier circuits for producing high voltages.
2. Explain with circuit diagram, the working of simple voltage doubler circuit for generation of D.C high voltage.
3. Explain the different schemes for cascade connection of transformers for producing very high a.c. voltages.
4. load Why is a Cockcroft-Walton circuit preferred for voltage multiplier circuits? Explain its working with a schematic diagram.
5. Explain Cock Croft Walton voltage Multiplier circuit with neat circuit diagram. Show input and output wave form with certain.
6. Explain the no-load operation of a CockCroft- Walton voltage Multiplier circuit.
7. Derive expressions for ripple and voltage drop in cascaded voltage multiplier circuit.
8. State the chief advantages of resonant transformers.
9. What is tesla coil? How are damped high frequency oscillations obtained from a Tesla coil.
10. What is the principle of operation of resonant transformers? How is it advantageous over the cascade connected transformers?
11. Define the front and tail times of an impulse wave. What are the tolerances allowed as per specification?
12. Give the different circuits that produce impulse waves, explain clearly their merits and demerits.
13. How will you specify impulse generator? Describe the working of a multistage Marx impulse generator with a neat sketch. How is the basic arrangement modified to accommodate the wave time control?
14. Explain the different methods of producing switching impulses in the test laboratories.
15. Outline the method of tripping a multistage impulse generator using three electrode gap arrangements.
16. What is trigatrongap?Explain its function and operation.
17. Define an impulse wave and show that the output voltage of impulse generation circuit is double exponential in nature.
18. Give the general equation of a standard impulse wave and explain the wave shape giving the percentage tolerances allowed for front, tail and the peak.
19. Discuss the components of a multistage impulse generator of less than 1MV.

Module 3:

1. Explain the working principle of series capacitor peak voltmeter based on Chubb-Fortesque method.
2. Briefly explain factors influencing spark over voltage of sphere gap.
3. Write a short note on MIX- RC potential dividers.
4. Explain the principle of measurement of high AC voltage using sphere gap & discuss the effect of atmosphere condition for its calibration.
5. Describe the construction & working of Electrostatic voltmeter. State its advantages & limitations.
6. Write a short note on the resistance dividers.
7. Draw a neat schematic diagram of generating voltmeter & explain its operation & discuss its applications.
8. Which are the four main sources of errors in the measurements of impulse voltages with potential dividers?
9. Explain the Chubb- Fortesque method for peak voltage measurement. Bring out the sources that contribute to the errors in the measurement.
10. Explain the importance of Sphere gap in Measurement of high voltages and high currents.
11. How Capacitance Potential Dividers are used for the impulse voltage measurements.

Module 4:

1. Explain the different theories of charge formation in clouds.
2. What are the mechanisms by which lighting strokes develop and induce overvoltages on overhead power lines
3. Give the mathematical models for lighting discharges and explain them
4. What are the causes for switching and power frequency overvoltages? How are they controlled in power systems
5. What are the different methods employed for lightning protection of overhead lines?
6. What is a surge arrester? Explain its function as a shunt protective device.
7. What is meant by insulation co-ordination? How are are the protective devices

   Chosen for optimal insulation level in a power system?
8. Explain the different aspects of insulation design and insulation co-ordination

Module 5:

1. What are partial discharges & how are they detected under power frequency operating conditions?
2. Discuss the method of balanced detection for locating partial discharges in electrical equipment.
3. Explain the method of measurement of capacitance and tan ∂ using H.V. Schering bride.
4. Why partial discharge tests are performed on H.V. cables? Describe partial discharge testing of cables.
5. Write a short note on Transformer ratio Arm Bridge.
6. Explain the method of measuring dielectric loss at power frequency using high voltage Schering Bridge.
7. Explain the partial discharge diction using straight detectors.
8. Define the following i) Disruptive discharge voltage ii) withstand voltage iii) 50% flash over voltage. iv)Creeping distance.
9. Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for

locating the failure.

10 Name and explain in brief different tests that are carried out on high voltage insulators.

11 What are the different power frequency tests done on insulators? Mention the procedure for testing.

12 Mention the different electrical tests done on isolators and circuit breakers.

13 Why is synthetic testing advantageous over the other testing methods for short circuit tests? Give the layout for synthetic testing.

14 What is the significance of impulse tests? Briefly explain the impulse testing of insulators.

Prepared by	Checked by		
Prof. O. B. Heddurshetti	**Prof. O. B. Heddurshetti**	**HOD**	**Principal**

Subject Title	**RESEARCH METHODOLOGY & IPR**		
Subject Code	BRM557	**CIE Marks**	50
Number of Lecture Hrs / Week(L:T:P:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof. S.G.Huddar	**Designation:** Asst. Professor	**Experience:**12
No. of times course taught: 02	**Specialization:** Power System Engineering	

1.0 Course Objectives

- To understand the knowledge on basics of research and its types.
- To learn the concept of Literature Review, Technical Reading, Attributions and Citations.
- To learn Ethics in Engineering Research.
- To discuss the concepts of Intellectual Property Rights in engineering.

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
C310.1	To know the meaning of engineering research.	L2	1,2,3,8,9,10,12
C310.2	To know the procedure of Literature Review and Technical Reading.	L3	1,2,3,8,12
C310.3	To know the fundamentals of patent laws and drafting procedure.	L3	1,2,3,5,8,9,10,12
C310.4	Understanding the copyright laws and subject matters of copyrights and designs.	L3	1,2,3,5,8,9,10,12
C310.5	Understanding the basic principles of design rights.	L3	1,2,3,5,8,9,10,12

4.0 Course Content

Module-1

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem.
Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Module-2

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Module-3

Introduction to Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting. Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

Process of Patenting. Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

Module-4

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Module-5

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. **IP Organizations in India. Schemes and Programmes**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VI, VII & VIII	Project	Renewable Energy Sources projects

6.0 Relevance to Real World

Sl. No	Real World Mapping
01	To design & implementation of Renewable energy source projects.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical	Industrial Visit

8.0 Books Used and Recommended to Students

Text Books

1. Sr. Santosh M Nejakar, Dr.Harish Bendigeri "Research Methodology and Intelluctual Property Rights", ISBN 978-93-5987-928-4, Edition:2023-24.

Reference Books

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488- 4
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9

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

Website and Internet Contents References
https://onlinecourses.nptel.ac.in
https://www.tutorialspoint.com/fundamentals-of-research-methodology

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of Mixed Methods Research	https://journals.sagepub.com/
2	International Journal of Social Research Methodology	https://www.tandfonline.com/

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 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 time table, 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.

Marks scored shall be proportionally reduced to 50 marks.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	Introduction: Meaning of Research, Objectives of Engineering Research.	20
	2	Types of Engineering Research.	
	3	Motivation in Engineering Research.	
	4	Finding and Solving a Worthwhile Problem.	
	5	Ethics in Engineering Research.	
	6	Ethics in Engineering Research Practice.	
	7	Types of Research Misconduct.	
	8	Ethical Issues Related to Authorship.	
2	9	**Literature Review and Technical Reading**, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases.	20
	10	Web of Science, Google and Google Scholar.	
	11	Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading.	
	12	Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.	
	13	**Attributions and Citations**: Giving Credit Wherever Due, Citations: Functions and Attributes.	
	14	Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets.	
	15	Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged.	
	16	Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	

3	17	**Introduction To Intellectual Property:** Role of IP in the Economic and Cultural Development of the Society.	
	18	Major Amendments in IP Laws and Acts in India, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India.	
	19	**Patents:** Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights.	
	20	Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements.	
	21	Avoid Public Disclosure of an Invention before Patenting. Process of Patenting. Prior Art Search.	
	22	Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Types of National Bodies Dealing with Patent Affairs.	
	23	Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be obtained?	
	24	Patent Applications, Commonly Used Terms in Patenting.	
4	25	**Copyrights and Related Rights:** Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements.	
	26	Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence.	
	27	Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights.	
	28	Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher.	20
	29	Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society.	
	30	**Trademarks:** Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols.	
	31	Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India.	
	32	Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.	
5	33	Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India.	
	34	Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design.	
	35	Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs.	
	36	Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.	20
	37	Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India.	
	38	Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks.	

	39	Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent.	
	40	Case study of Basmati patent. IP Organizations In India. Schemes and Programmes	

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 are able to know the meaning of engineering research, patent laws, copyright laws and basic principles of design rights.	All modules	4	Individual Activity.	Text Book 1
2	Quiz	Students are able to know the meaning of engineering research, patent laws, copyright laws and basic principles of design rights.	All modules	9	Individual Activity.	Text Book 2

15.0 QUESTION BANK

MODULE 1

1. Explain the term "Research" in the context of engineering.
2. Classify different types of engineering research and elaborate on the distinctive characteristics of each type. Provide examples to support your classifications.
3. Discuss the importance of finding and solving a worthwhile problem in engineering research. How does this contribute to the advancement of knowledge and technology?
4. Define research misconduct in the context of engineering research. Provide examples of behaviors that are considered research misconduct.
5. Discuss the importance of ethics in engineering research. How does ethical conduct contribute to the credibility and integrity of scientific inquiry?
6. Define Engineering research and list its aims and objectives.
7. Explain briefly about research cycle and verify with the research flow diagram.
8. Explain different types of engineering research.
9. What are the key ethical issues related to authorship? Explain any one.
10. Write a short note on i) Fabrication ii) Plagiarism.

MODULE 2

1. Define the term "Literature Review" in the context of research. Explain its significance in the research process.
2. Compare and contrast the features and functionalities of bibliographic databases such as Web of Science, Google Scholar, and Google. Discuss the strengths and limitations of each in the context of academic research.
3. Explain the functions and attributes of citations in academic writing. How do citations contribute to the credibility and reliability of a research paper?
4. Discuss the impact of titles and keywords on citations. How can researchers optimize these elements to enhance the visibility and accessibility of their work?

5. Discuss the ethical considerations of citing datasets in research papers.
6. Explain about the importance of Literature review and Technical reading.
7. Explain the various steps involved in critical and creative reading.
8. How does new and existing knowledge can contribute to the research process? Explain relevant points.

MODULE 3

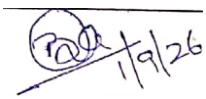
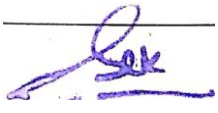
1. Explain the role of Intellectual Property in the economic development of society. How does it contribute to fostering innovation and creativity?
2. Analyze the challenges and benefits associated with the globalization of Intellectual Property. How does the global nature of IP impact both developed and developing nations?
3. Discuss a historical overview of Intellectual Property in India, highlighting key milestones and developments.
4. Examine the rights associated with patents. How do patents grant exclusive rights to inventors, and what limitations exist?
5. Discuss the considerations involved in the decision-making process of whether or not to patent an invention.
6. Describe the intellectual property rights and list its types.
7. Explain about the key aspect of Patent Law.
8. Describe the patent procedure in India.

MODULE 4

1. Analyze the rights of the author in copyright. Discuss the implications of copyright infringements and why it is considered a criminal and cognizable offense.
2. Explain the process of copyright registration, including the fee structure and the significance of the copyright symbol.
3. Analyze the concept of joint authorship in copyright. What implications does joint authorship have on copyright ownership and protection?
4. List the eligibility criteria for a trademark. Who is eligible to apply for a trademark, and what are the key requirements?
5. Discuss the necessity for the registration of a trademark. What are the implications of not registering a trademark, and under what circumstances might registration be beneficial?
6. What are the roles and functions of the copyright board and copyright society in administering copyright law and regulations?
7. Copyright infringement is a criminal and cognizable offence. Explain How and why?

MODULE 5

1. Discuss the acts and laws that govern industrial designs. How do these legal frameworks safeguard design rights?
2. Analyze the concept of design rights. What rights are associated with industrial designs, and how do they differ from other forms of intellectual property?
3. Describe the procedure for the registration of industrial designs, including the steps involved in the application process.
4. Examine the identification and classification of registered GIs in India. How are GIs categorized, and how does this classification impact their protection?
5. Analyze the protection mechanisms for Geographical Indications. How are GIs safeguarded from misuse or unauthorized use?
6. Describe the overall ecosystem and significance of Geographical Indications in India.
7. What are the rights of the Owner of designs? Explain.

Prepared & Checked by		
		
Prof. S. G. Huddar	**HOD**	**Principal**

Subject Title	**ENVIRONMENTAL STUDIES**		
Subject Code	BESK508	**IA Marks**	50
Number of Lecture Hrs /	02	**SE Exam Marks**	50
Total Number of Lecture Hrs	30	**Exam Hours**	01
CREDITS – 01			

FACULTY DETAILS:		
Name: Smt.R.B.Kamatagi	Designation: Asst. Professor	Experience: 14yrs
No. of times course taught: 1	**Specialization:** Bontay(Microbiology)	

1.0 Prerequisite Subjects:

Fundamentals of Chemistry, Physics, Mathematics, Biology, Engineering, Anthropology, Sociology, (Social problems), Economics (production, consumption, and transfer of wealth), management, Ecology Knowledge are required.

2.0 Course Learning Objectives

1. Recognize major concepts in environmental sciences and demonstrate in-depth understanding of the environment.
2. Develop analytical skills, critical thinking, and demonstrate problem-solving skills using scientific techniques.
3. Demonstrate the knowledge and training for entering graduate or professional schools, or the job market.

3.0 Course Outcomes

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

Course Code	Course Outcome	RBT level	POs
	To understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.	L1,L2	1,2,3,6,7,9 ,10,12
	To Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment as legislation.	L1, L2	1,2,3,6,7,9, 10,12
	Apply their ecological knowledge to illustrate and grasp the problem and describe the realities that managers face when dealing with complex issues	L1, L2	1,2,3,6,7,9, 10,12
Total Hours of instruction		**30**	

4.0 Course Content

Module-1: ECOSYSTEM AND SUSTAINABILITY

Ecosystems (Structure and Function): Forest, Desert, Wetlands, River, Oceanic and Lake.

Sustainability: 17 SDGs- History, targets, implementation, Capacity Development

Teaching-Learning Process: Chalk and talk, PowerPoint presentation and animation tools

Module 2: NATURAL RESOURCE MANAGEMENT

Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind.

Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining - case studies and Carbon Trading.

Teaching-Learning Process: Chalk and talk, PowerPoint presentation and animation tools

Module 3: ENVIRONMENTAL POLLUTION & WASTE MANAGEMENT

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.

Waste Management: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Teaching-Learning Process: Chalk and talk, PowerPoint presentation and animation tools

Module 4: GLOBAL ENVIRONMENTAL ISSUES

Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Teaching-Learning Process: Chalk and talk, PowerPoint presentation and animation tools

Module 5: ENVIRONMENTAL LEGISLATION

Environmental Legislation : Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste management Rule - 2022, Biomedical Waste management- 2016.

Teaching-Learning Process: Chalk and talk, PowerPoint presentation and animation tools

5.0 Relevance to future subjects

Sl. No.	Semester	Subject	Topics
01	Common to all	Common to all engineering Subjects	Sustainable development, waste management, Pollution control, Energy systems, Environmental issues.

6.0 Relevance to Real World

Sl. No	Real World Mapping
01	All engineering applications / projects leading to the sustainable development, waste management, pollution control, to resolve global related issues.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL	http://nptel.ac.in/courses

8.0 Books Used and Recommended to Students

Text Books
1. Benny Joseph (2005), "Environmental Studies", Tata McGraw – Hill Publishing Company Limited.
2. R.J.Ranjit Daniels and Jagadish Krishnaswamy, (2009), "Environmental Studies", Wiley India Private Ltd., New Delhi.

3. R Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005,

4. Aloka Debi, "Environmental Science and Engineering", Universities Press (India) Pvt. Ltd. 2012.

Reference Books

1. Raman Sivakumar, "Principals of Environmental Science and Engineering", Second Edition, Cengage learning Singapore, 2005

2. P. Meenakshi, "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006

3. S.M. Prakash, "Environmental Studies", Elite Publishers Mangalore, 2007

4. Erach Bharucha, "Text Book of Environmental Studies", for UGC, University press, 2005

5. G.Tyler Miller Jr., "Environmental Science – working with the Earth", Tenth Edition, Thomson Brooks /Cole, 2004

6. G.Tyler Miller Jr., "Environmental Science – working with the Earth", Eleventh Edition, Thomson Brooks /Cole, 2006

7. Dr.Pratiba Sing, Dr.AnoopSingh and Dr.Piyush Malaviya, "Text Book of Environmental and Ecology", Acme Learning Pvt. Ltd. New Delhi.

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

Website and Internet Contents References

Web links and Video Lectures:

https://archive.nptel.ac.in/courses/109/105/109105190/
https://nptel.ac.in/courses/120/108/120108005/
https://nptel.ac.in/courses/120/108/120108002/
https://nptel.ac.in/courses/120/108/120108004/
https://nptel.ac.in/courses/105/102/105102089/
https://www.my-mooc.com/en/categorie/environmental-science
https://academicearth.org/environmental-studies/
https://sdgs.un.org/goals

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	Environmental-science	http://nlspub.ac.in/category/journals/journal-of-environmental-law-policy-and-development/
2	Environmental-research	https://www.journals.elsevier.com/environmental-research

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% (40marks out of 100)

in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination)taken together

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

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

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course)

CIE methods /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 subject (duration 01 hours)

Question paper pattern:

1. The Question paper will have 50 objective questions
2. Each question will be for 01 marks
3. Students will have to answer all the questions on an OMR Sheet.
4. The Duration of the Exam will be 01 hour

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecturer	% of Portion
1	1.	**Module-1: ECOSYSTEM AND SUSTAINABILITY Ecosystems** (Structure and Function): Forest and Desert	**20**
	2.	**Ecosystems** (Structure and Function):Wetlands and River	
	3.	**Ecosystems** (Structure and Function): Oceanic and Lake.	
	4.	**Sustainability**: 17 SDGs- History	
	5.	**Sustainability**: 17 SDGs- targets	
	6.	**Sustainability**: 17 SDGs- implementation, Capacity Development	
2	7.	**Module 2: NATURAL RESOURCE MANAGEMENT Advances in Energy Systems** (Merits, Demerits, Global Status and Applications): Hydrogen and Solar	**20**
	8.	**Advances in Energy Systems** (Merits, Demerits, Global Status and Applications): OTEC	
	9.	**Advances in Energy Systems** (Merits, Demerits, Global Status and Applications): Tidal and Wind.	
	10.	**Natural Resource Management** (Concept and case-studies): Disaster Management	

	11.	**Natural Resource Management** (Concept and case-studies): Sustainable Mining - case studies	
	12.	**Natural Resource Management** (Concept and case-studies): Carbon Trading.	
3	13.	**Module 3: ENVIRONMENTAL POLLUTION & WASTE MANAGEMENT: Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution.	**20**
	14.	**Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Noise pollution	
	15.	**Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Soil Pollution and Air Pollution.	
	16.	**Waste Management:** Bio-medical Wastes	
	17.	**Waste Management:** Solid waste; Hazardous wastes; E-wastes	
	18.	**Waste Management:** Industrial and Municipal Sludge.	
4	19.	**Module 4: GLOBAL ENVIRONMENTAL ISSUES** **Global Environmental Concerns (**Concept, policies and case-studies): Ground water depletion/recharging	**20**
	20.	**Global Environmental Concerns (**Concept, policies and case-studies Climate Change; Acid Rain.	
	21.	**Global Environmental Concerns (**Concept, policies and case-studies): Ozone Depletion	
	22.	**Global Environmental Concerns (**Concept, policies and case-studies Radon and Fluoride problem in drinking water	
	23.	**Global Environmental Concerns (**Concept, policies and case-studies): Environmental Toxicology.	
	24.	**Global Environmental Concerns (**Concept, policies and case-studies): Resettlement and rehabilitation of people	
5	25.	**Module 5: ENVIRONMENTAL LEGISLATION**	**20**
	26.	**Environmental Legislation :** Water Act 1974,	
	27.	**Environmental Legislation :** Air Act 1981	
	28.	**Environmental Legislation :** Environmental Protection Act 1984,	
	29.	**Environmental Legislation :** Solid Waste Management Rules-2016,	
	30.	**Environmental Legislation :** E- Waste management Rule - 2022, Biomedical Waste management- 2016.	

13.0 Assignments

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions/ Write up	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity.	Book 1, of the reference list. Website of the Reference list
2	Assignment 1: University Questions/ Write up	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
3	Assignment 1: University Questions/ Write up	Students study the Topics and write the Answers. Get practice	Module 3 of the syllabus	6	Individual Activity.	Book 1, 2 of the reference list. Website of the

		to solve university questions.				Reference list
4	Assignment 2: University Questions/ Write up	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
5	Assignment 2: University Questions/ Write up	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list

14.0 QUESTION BANK

Module-1

Q1. What is the main source of energy in a forest ecosystem?
a) Soil nutrients
b) Sunlight
c) Water
d) Organic matter
Answer: b) Sunlight
Q2. Which of the following adaptations helps plants survive in desert ecosystems?
a) Broad leaves for capturing sunlight
b) Shallow roots for surface water
c) Deep roots to access underground water
d) Large leaves to increase transpiration
Answer: c) Deep roots to access underground water
Q3. Wetlands are often referred to as "nature's kidneys" because:
a) They store excess nutrients
b) They filter pollutants and purify water
c) They provide oxygen for aquatic life
d) They store solar energy
Answer: b) They filter pollutants and purify water
Q4. What is the term used to describe the area where a river meets the ocean?
a) Delta
b) Tributary
c) Estuary
d) Watershed
Answer: c) Estuary
Q5. Which of the following is the most productive zone in the ocean, supporting the greatest biodiversity?
a) Abyssal zone
b) Bathyal zone
c) Photic zone
d) Hadal zone
Answer: c) Photic zone
Q6. In a lake ecosystem, which zone is near the shore and rich in biodiversity?
a) Profundal zone
b) Limnetic zone
c) Littoral zone
d) Benthic zone
Answer: c) Littoral zone
Q7. The process of converting sunlight into chemical energy by plants is called:
a) Respiration
b) Photosynthesis
c) Decomposition
d) Nitrogen fixation
Answer: b) Photosynthesis
Q8. Which of the following organisms would be considered a primary consumer in a forest ecosystem?
a) Rabbit

b) Wolf
c) Oak tree
d) Mushroom
Answer: a) Rabbit
Q9. Which of the following is a typical characteristic of desert ecosystems?
a) High rainfall
b) Low evaporation rate
c) Sparse vegetation
d) High population density of organisms
Answer: c) Sparse vegetation
Q10. What is the main reason why phytoplankton are important to marine ecosystems?
a) They decompose organic matter
b) They provide shelter for fish
c) They are the primary producers and form the base of the food web
d) They consume large predators
Answer: c) They are the primary producers and form the base of the food web
11. When were the United Nations' 17 Sustainable Development Goals (SDGs) adopted?
a) 2000
b) 2010
c) 2015
d) 2020
Answer: c) 2015
12. Which of the following is NOT one of the 17 SDGs?
a) Gender equality
b) Zero hunger
c) Global disarmament
d) Climate action
Answer: c) Global disarmament
13. The SDGs aim to be achieved by which year?
a) 2025
b) 2030
c) 2050
d) 2040
Answer: b) 2030
14. Which of the following SDGs focuses on providing clean water and sanitation?
a) SDG 6
b) SDG 10
c) SDG 13
d) SDG 7
Answer: a) SDG 6
15. The principle of "Leave No One Behind" is central to the SDGs. What does this principle emphasize?
a) Focusing on wealthier nations
b) Achieving economic growth only
c) Prioritizing the most vulnerable and marginalized groups
d) Expanding urban infrastructure
Answer: c) Prioritizing the most vulnerable and marginalized groups
16. Which of the following targets falls under SDG 1 (No Poverty)?
a) End hunger and ensure food security
b) Ensure affordable and clean energy
c) Eradicate extreme poverty for all people everywhere
d) Promote economic growth and decent work
Answer: c) Eradicate extreme poverty for all people everywhere
17. Capacity development for achieving the SDGs involves:
a) Focusing solely on government-led efforts
b) Strengthening the skills and knowledge of individuals, organizations, and societies
c) Increasing private-sector profits
d) Reducing foreign aid
Answer: b) Strengthening the skills and knowledge of individuals, organizations, and societies
18. Which of the following SDGs is most closely linked to addressing climate change?
a) SDG 7 - Affordable and Clean Energy
b) SDG 13 - Climate Action
c) SDG 15 - Life on Land

d) SDG 9 - Industry, Innovation, and Infrastructure
Answer: b) SDG 13 - Climate Action
19. The 2030 Agenda for Sustainable Development was built upon which earlier initiative?
a) The Paris Agreement
b) The Millennium Development Goals (MDGs)
c) The Kyoto Protocol
d) The Bali Roadmap
Answer: b) The Millennium Development Goals (MDGs)
20. Implementation of the SDGs requires participation from which of the following groups?
a) Only national governments
b) Private sector and corporations
c) Civil society, governments, the private sector, and international organizations
d) Only non-governmental organizations (NGOs)
Answer: c) Civil society, governments, the private sector, and international organizations

Module-2

1. Which of the following is a primary advantage of hydrogen as a fuel?
a) High greenhouse gas emissions
b) Zero-emission when burned
c) Low energy density
d) Difficult storage
Answer: b) Zero-emission when burned
2. Which country is the global leader in installed solar photovoltaic (PV) capacity?
a) United States
b) Germany
c) China
d) India
Answer: c) China
3. A major limitation of wind energy is:
a) High operational cost
b) Noise pollution and visual impact
c) Lack of renewable potential
d) High greenhouse gas emissions
Answer: b) Noise pollution and visual impact
4. What is one of the biggest challenges of using hydrogen as an energy source?
a) Its low abundance
b) Difficulty in producing it efficiently without fossil fuels
c) Low energy density compared to gasoline
d) High toxicity
Answer: b) Difficulty in producing it efficiently without fossil fuels
5. Ocean Thermal Energy Conversion (OTEC) uses the temperature difference between:
a) Deep and surface ocean water
b) Ocean and land temperature
c) Tropical and polar ocean water
d) Ocean and air temperature
Answer: a) Deep and surface ocean water
6. Which of the following is a key benefit of solar energy?
a) Continuous energy production
b) High greenhouse gas emissions
c) Abundant and renewable
d) Requires high water consumption
Answer: c) Abundant and renewable
7. Tidal energy is considered a reliable energy source because:
a) It depends on sunlight
b) Tides are predictable and regular
c) It is easily transportable
d) It has low efficiency

Answer: b) Tides are predictable and regular
8. Which of the following is a demerit of solar power?
a) Intermittency due to weather conditions
b) High greenhouse gas emissions
c) Difficulty in land use
d) Limited lifetime of solar panels
Answer: a) Intermittency due to weather conditions
9. Which of the following countries is known for leading tidal energy projects?
a) Japan
b) South Korea
c) Australia
d) Brazil
Answer: b) South Korea
10. Wind energy has the greatest potential in which geographic region?
a) Equatorial regions
b) Desert regions
c) Coastal and open plains
d) Dense urban centers
Answer: c) Coastal and open plains
11. Which of the following is a major disadvantage of OTEC systems?
a) High operational costs and infrastructure requirements
b) Dependence on fossil fuels
c) Low energy conversion efficiency
d) Limited locations with required temperature differentials
Answer: d) Limited locations with required temperature differentials
12. Which of the following hydrogen production methods is considered most sustainable?
a) Steam methane reforming
b) Electrolysis using renewable energy
c) Gasification of coal
d) Thermo-chemical conversion
Answer: b) Electrolysis using renewable energy
13. Which of the following is a primary objective of disaster management?
a) Maximizing economic losses
b) Strengthening resilience and preparedness
c) Ignoring risk mitigation strategies
d) Relocating populations permanently
Answer: b) Strengthening resilience and preparedness
14. Which country implemented the first cap-and-trade system for carbon emissions?
a) United States
b) Germany
c) Japan
d) European Union
Answer: d) European Union
15. Sustainable mining practices are aimed at:
a) Extracting as many resources as possible in the shortest time
b) Minimizing environmental impacts and ensuring community benefits
c) Prioritizing short-term profits over ecological balance
d) Ignoring the impact on local communities
Answer: b) Minimizing environmental impacts and ensuring community benefits
16. Which of the following is an example of a sustainable mining case study?
a) The Ok Tedi Mine in Papua New Guinea
b) The Diavik Diamond Mine in Canada
c) The West Virginia coal mines in the USA
d) The Athabasca oil sands in Canada
Answer: b) The Diavik Diamond Mine in Canada

17. Which organization typically leads global carbon trading efforts?
a) World Health Organization (WHO)
b) International Monetary Fund (IMF)
c) United Nations Framework Convention on Climate Change (UNFCCC)
d) International Atomic Energy Agency (IAEA)
Answer: c) United Nations Framework Convention on Climate Change (UNFCCC)
18. Which of the following is a component of effective disaster management?
a) Early warning systems
b) Limiting access to information
c) Delaying recovery efforts
d) Ignoring environmental impact assessments
Answer: a) Early warning systems
19. Carbon trading works by:
a) Allowing countries and companies to buy and sell emissions allowances
b) Increasing global greenhouse gas emissions
c) Forcing companies to produce more emissions
d) Reducing carbon dioxide removal efforts
Answer: a) Allowing countries and companies to buy and sell emissions allowances
20. A notable disaster management case study in India is the:
a) Chernobyl disaster
b) Uttarakhand floods
c) Fukushima nuclear accident
d) Hurricane Katrina
Answer: b) Uttarakhand floods

Module-3
1. Which of the following is a major source of surface water pollution?
a) Industrial effluents
b) Solar radiation
c) Wind energy
d) Desertification
Answer: a) Industrial effluents
2. The primary cause of groundwater pollution is:
a) Overfishing
b) Leaching of chemicals from landfills
c) Noise from traffic
d) Airborne particles
Answer: b) Leaching of chemicals from landfills
3. Which of the following gases is most commonly associated with air pollution in urban areas?
a) Methane (CH_4)
b) Nitrogen dioxide (NO_2)
c) Oxygen (O_2)
d) Hydrogen (H_2)
Answer: b) Nitrogen dioxide (NO_2)
4. Noise pollution is measured in which unit?
a) Pascals
b) Decibels
c) Watts
d) Joules
Answer: b) Decibels
5. Which of the following is a primary effect of soil pollution?
a) Increased crop yields
b) Reduced soil fertility
c) Decrease in pesticide use
d) Enhanced biodiversity
Answer: b) Reduced soil fertility
6. The Clean Air Act in the United States is designed to:
a) Regulate noise levels in urban areas
b) Control emissions of harmful air pollutants

c) Monitor solid waste disposal methods
d) Manage water quality in rivers and lakes
Answer: b) Control emissions of harmful air pollutants
7. Eutrophication, a result of nutrient pollution in water bodies, primarily causes:
a) Improved fish habitats
b) Oxygen depletion and dead zones
c) Enhanced water clarity
d) Increased freshwater availability
Answer: b) Oxygen depletion and dead zones
8. One of the key preventive measures for groundwater pollution is:
a) Increased mining activities
b) Proper waste disposal and landfill management
c) Building more factories near water bodies
d) Increased pesticide application in agriculture
Answer: b) Proper waste disposal and landfill management
9. The major contributor to air pollution from vehicles is:
a) Carbon monoxide (CO)
b) Nitrous oxide (N_2 O)
c) Hydrogen sulfide (H_2 S)
d) Ozone (O_3)
Answer: a) Carbon monoxide (CO)
10. Which Indian law focuses on the prevention and control of water pollution?
a) The Environment Protection Act, 1986
b) The Air (Prevention and Control of Pollution) Act, 1981
c) The Water (Prevention and Control of Pollution) Act, 1974
d) The Noise Pollution (Regulation and Control) Rules, 2000
Answer: c) The Water (Prevention and Control of Pollution) Act, 1974
Waste Management: Bio-medical Wastes, Solid Waste, Hazardous Wastes, E-wastes, Industrial and Municipal Sludge
11. Which of the following is classified as hazardous waste?
a) Food scraps
b) Lead batteries
c) Organic fertilizer
d) Plastic bottles
Answer: b) Lead batteries
12. Biomedical waste should be disposed of in:
a) Compost bins
b) Open fields
c) Incinerators
d) Public parks
Answer: c) Incinerators
13. Which of the following is a key environmental issue related to e-waste?
a) Excessive use of freshwater resources
b) Heavy metal contamination in landfills
c) Increased air pollution
d) Noise from electronic devices
Answer: b) Heavy metal contamination in landfills
14. Solid waste management in urban areas is primarily aimed at:
a) Burning all waste in open spaces
b) Reducing, reusing, and recycling waste materials
c) Increasing landfill sizes indefinitely
d) Disposing waste in rivers and lakes
Answer: b) Reducing, reusing, and recycling waste materials
15. The Safe Disposal of Hazardous Waste Rule was introduced in India in:
a) 1986
b) 2000
c) 1990
d) 2008
Answer: d) 2008
16. Which of the following is the most environmentally friendly method for handling municipal solid waste?
a) Open dumping
b) Landfilling
c) Recycling and composting

d) Incineration
Answer: c) Recycling and composting
17. The Basel Convention relates to:
a) Trade regulations
b) Transboundary movement of hazardous wastes
c) Water management
d) Noise pollution control
Answer: b) Transboundary movement of hazardous wastes
18. One of the most harmful components of e-waste is:
a) Silicon chips
b) Copper wires
c) Lead and mercury
d) Plastic casings
Answer: c) Lead and mercury
19. Which of the following is a best practice for managing industrial sludge?
a) Dumping it in local water bodies
b) Treating it in wastewater treatment plants
c) Using it for construction purposes
d) Burying it in forests
Answer: b) Treating it in wastewater treatment plants
20. A major issue with biomedical waste management is the spread of:
a) Noise pollution
b) Infectious diseases
c) Soil fertility
d) Renewable energy
Answer: b) Infectious diseases

Module-4
1. Groundwater depletion is primarily caused by:
a) Reduced atmospheric pressure
b) Over-extraction for agriculture and urban use
c) Increased rainfall
d) Glacier melting
Answer: b) Over-extraction for agriculture and urban use
2. Which method is commonly used to recharge depleted groundwater resources?
a) Deforestation
b) Urbanization
c) Rainwater harvesting
d) Salination
Answer: c) Rainwater harvesting
3. Which of the following gases is a major contributor to climate change?
a) Oxygen (O_2)
b) Carbon dioxide (CO_2)
c) Nitrogen (N_2)
d) Argon (Ar)
Answer: b) Carbon dioxide (CO_2)
4. Which international agreement was designed to reduce global greenhouse gas emissions?
a) Kyoto Protocol
b) Montreal Protocol
c) Stockholm Convention
d) Basel Convention
Answer: a) Kyoto Protocol
5. Acid rain is primarily caused by:
a) Overuse of water in agriculture
b) Emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) from industrial activities
c) Excess ozone in the atmosphere
d) Pesticides used in farming
Answer: b) Emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) from industrial activities
6. The pH of acid rain is typically:
a) Above 7
b) Neutral
c) Below 5.6

d) Exactly 7.0
Answer: c) Below 5.6
7. Ozone depletion in the stratosphere is primarily caused by:
a) Carbon dioxide (CO_2) emissions
b) Chlorofluorocarbons (CFCs)
c) Nitrogen oxides (NOx)
d) Methane (CH_4)
Answer: b) Chlorofluorocarbons (CFCs)
8. Which of the following international agreements targets the protection of the ozone layer?
a) Paris Agreement
b) Montreal Protocol
c) Kyoto Protocol
d) Nagoya Protocol
Answer: b) Montreal Protocol
9. Radon, a naturally occurring radioactive gas, poses a risk to human health primarily by causing:
a) Skin cancer
b) Lung cancer
c) Waterborne diseases
d) Heart disease
Answer: b) Lung cancer
10. Fluoride contamination in drinking water at high levels can cause:
a) Fluorosis
b) Respiratory problems
c) Cardiovascular diseases
d) Blindness
Answer: a) Fluorosis
11. Which state in India is known for severe fluoride contamination in its groundwater?
a) Kerala
b) Rajasthan
c) Punjab
d) West Bengal
Answer: b) Rajasthan
12. Resettlement and rehabilitation are most commonly associated with:
a) Urban planning
b) Large-scale development projects like dams and mining
c) Industrial pollution
d) Deforestation
Answer: b) Large-scale development projects like dams and mining
13. Which project in India is a significant case study of resettlement and rehabilitation issues?
a) Yamuna River Project
b) Narmada Dam Project
c) Delhi Metro Expansion
d) Sunderbans Development Project
Answer: b) Narmada Dam Project
14. Environmental toxicology primarily deals with:
a) The study of economic development
b) The effects of pollutants on ecosystems and human health
c) Preservation of cultural heritage
d) Noise pollution in urban areas
Answer: b) The effects of pollutants on ecosystems and human health
15. Which of the following is considered a persistent organic pollutant (POP)?
a) Carbon dioxide
b) DDT
c) Methane
d) Nitrogen dioxide
Answer: b) DDT
16. What is the main health risk associated with long-term exposure to arsenic in drinking water?
a) Liver failure
b) Skin cancer and other cancers
c) Tuberculosis
d) Cardiovascular disease
Answer: b) Skin cancer and other cancers

17. The Bhopal Gas Tragedy, a landmark environmental disaster in India, involved the release of which toxic chemical?
a) Carbon monoxide
b) Methane
c) Methyl isocyanate
d) Lead
Answer: c) Methyl isocyanate
18. Which of the following is a potential impact of climate change on global sea levels?
a) Stabilization of sea levels
b) Significant decrease in sea levels
c) Rising sea levels due to melting polar ice caps and thermal expansion of water
d) Increased salinity in the deep ocean
Answer: c) Rising sea levels due to melting polar ice caps and thermal expansion of water
19. What is a key preventive measure for acid rain?
a) Banning the use of renewable energy
b) Reducing emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) through clean energy technologies
c) Increasing coal consumption
d) Increasing deforestation
Answer: b) Reducing emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) through clean energy technologies
20. The term "environmental refugees" refers to:
a) People displaced due to natural disasters, climate change, or environmental degradation
b) Individuals seeking better job opportunities
c) Political refugees fleeing conflict
d) Tourists stranded due to weather conditions
Answer: a) People displaced due to natural disasters, climate change, or environmental degradation

Module-5

1. The Water (Prevention and Control of Pollution) Act was enacted in which year?
a) 1981
b) 1984
c) 1974
d) 1992
Answer: c) 1974
2. The main objective of the Water Act of 1974 is to:
a) Promote air quality
b) Prevent and control water pollution
c) Increase groundwater levels
d) Promote waste recycling
Answer: b) Prevent and control water pollution
3. Which body is responsible for implementing the Water Act at the central level?
a) National Green Tribunal (NGT)
b) Central Pollution Control Board (CPCB)
c) Ministry of Environment, Forest, and Climate Change (MoEFCC)
d) Indian Meteorological Department (IMD)
Answer: b) Central Pollution Control Board (CPCB)
4. According to the Water Act, who can apply for consent to establish and operate any industry or process that discharges sewage or effluents?
a) Any government official
b) The owner or occupier of the industry
c) A resident of the locality
d) Only the central government
Answer: b) The owner or occupier of the industry
5. Violation of the Water Act can lead to which of the following penalties?
a) Fines or imprisonment
b) Community service
c) Confiscation of property
d) Increased taxes
Answer: a) Fines or imprisonment
Air Act (1981)
6. The Air (Prevention and Control of Pollution) Act was introduced in which year?
a) 1974
b) 1981
c) 1986

d) 1991
Answer: b) 1981
7. Which pollutants are regulated under the Air Act of 1981?
a) Industrial and vehicular emissions
b) Groundwater pollutants
c) Plastic waste
d) Ocean pollutants
Answer: a) Industrial and vehicular emissions
8. The Air Act aims to:
a) Encourage deforestation
b) Prevent and control air pollution
c) Reduce soil erosion
d) Promote biofuel usage
Answer: b) Prevent and control air pollution
9. Under the Air Act, the state pollution control boards have the authority to:
a) Issue licenses for timber extraction
b) Enforce emission standards and shut down polluting units
c) Monitor water levels in rivers
d) Issue guidelines for wildlife conservation
Answer: b) Enforce emission standards and shut down polluting units
10. What happens if someone fails to comply with the provisions of the Air Act?
a) They receive subsidies for renewable energy projects
b) They can be penalized with imprisonment or fines
c) They are required to plant trees
d) They are issued a warning with no legal consequences
Answer: b) They can be penalized with imprisonment or fines
Environmental Protection Act (1986)
11. The Environmental Protection Act (EPA) was enacted in the wake of which major environmental disaster?
a) Bhopal Gas Tragedy
b) Chernobyl Disaster
c) Uttarakhand Floods
d) Amazon Forest Fires
Answer: a) Bhopal Gas Tragedy
12. Which of the following is a key feature of the Environmental Protection Act (1986)?
a) It focuses solely on air pollution
b) It provides a framework for the protection of the environment as a whole
c) It only regulates water pollution
d) It encourages the use of fossil fuels
Answer: b) It provides a framework for the protection of the environment as a whole
13. Under the Environmental Protection Act, the government has the power to:
a) Regulate industrial emissions and waste disposal practices
b) Implement international trade sanctions
c) Provide subsidies to polluting industries
d) License wildlife hunting
Answer: a) Regulate industrial emissions and waste disposal practices
14. Which ministry is responsible for overseeing the implementation of the Environmental Protection Act?
a) Ministry of Agriculture
b) Ministry of Environment, Forest, and Climate Change (MoEFCC)
c) Ministry of Water Resources
d) Ministry of Petroleum and Natural Gas
Answer: b) Ministry of Environment, Forest, and Climate Change (MoEFCC)
15. Under the Environmental Protection Act, pollution from which of the following can be controlled?
a) Only industrial waste
b) Air, water, land, and noise pollution
c) Only vehicular emissions
d) Only municipal solid waste
Answer: b) Air, water, land, and noise pollution
Solid Waste Management Rules (2016)
16. Which of the following is a new category of waste included in the Solid Waste Management Rules (2016)?
a) Hazardous waste
b) Biomedical waste
c) Sanitary waste

d) Radioactive waste
Answer: c) Sanitary waste
17. According to the Solid Waste Management Rules, what is the preferred method for managing waste?
a) Incineration
b) Open dumping
c) Waste segregation at source and recycling
d) Landfilling without treatment
Answer: c) Waste segregation at source and recycling
18. The Solid Waste Management Rules (2016) are applicable to:
a) Only urban households
b) Only rural areas
c) All residential and commercial entities in urban and rural areas
d) Only industrial units
Answer: c) All residential and commercial entities in urban and rural areas
E-Waste Management Rules (2022)
19. The E-Waste Management Rules (2022) primarily focus on:
a) Promoting fossil fuel use
b) Regulating the disposal and recycling of electronic waste
c) Banning the production of electronic devices
d) Reducing air pollution
Answer: b) Regulating the disposal and recycling of electronic waste
20. Under the E-Waste Management Rules (2022), which of the following is a key responsibility of producers?
a) Dumping e-waste in landfills
b) Collecting e-waste and ensuring proper disposal under the Extended Producer Responsibility (EPR) framework
c) Only manufacturing new electronic products
d) Promoting single-use electronics
Answer: b) Collecting e-waste and ensuring proper disposal under the Extended Producer Responsibility (EPR) framework

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			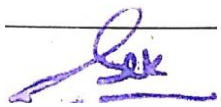
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