Department of Electrical & Electronics Engineering

Course File

HIGH VOLTAGE ENGINEERING

GR18A4021

IV B.Tech I Sem
2022-23

Dr. Vinay Kumar Awaar
Associate Professor

Gokaraju Rangaraju Institute of Engineering and Technology

(Autonomous)

Bachupally, Kukatpally, Hyderabad – 500090, TS, INDIA.

HIGH VOLTAGE ENGINEERING

Check List

VISION AND MISSION

Vision of the Institute

To be among the best of the institutions for engineers and technologists with attitudes, skills and knowledge and to become an epicentre of creative solutions.

Mission of the Institute

To achieve and impart quality education with an emphasis on practical skills and social relevance.

Vision of the Department

To impart technical knowledge and skills required to succeed in life, career and help society to achieve self sufficiency.

Mission of the Department

- To become an internationally leading department for higher learning.
- To build upon the culture and values of universal science and contemporary education.
- To be a center of research and education generating knowledge and technologies which lay groundwork in shaping the future in the fields of electrical and electronics engineering.
- To develop partnership with industrial, R&D and government agencies and actively participate in conferences, technical and community activities.

PEOS & POS

This Programme is meant to prepare our students to professionally thrive and to lead.During their progression:

Graduates will be able to

PEO 1: Graduates will have a successful technical or professional careers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Graduates will be able to acquire, use and develop skills as required for effective professional practices.

PEO 3: Graduates will be able to attain holistic education that is an essential prerequisite for being a responsible member of society.

PEO 4: Graduates will be engaged in life-long learning, to remain abreast in their profession and be leaders in our technologically vibrant society.

Programme Outcomes (B.Tech. – EEE)

At the end of the Programme, a graduate will have the ability to

PO-1: Ability to apply knowledge of mathematics, science, and engineering.

PO-2: Ability to identify, formulate, analyze engineering problems using engineering sciences.

PO-3: Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety..

PO-4: Ability to design and conduct experiments, as well as to analyze and interpret data with valid conclusions.

PO-5: Ability to utilize experimental, statistical and computational methods and tools necessary for modelling engineering activities.

PO-6: Ability to apply reasoning informed by the relative knowledge to evaluate societal, health, safety, legal and cultural issues and tasks applicable to the professional engineering practice.

PO-7: Ability to adapt broad education necessary to understand the impact of engineering solutions and obtain sustainability in a global, economic, environmental, and societal context.

PO-8: Ability to discover ethical principles and bind to professional and ethical responsibility.

PO-9: Ability to function as an individual and in multi-disciplinary teams.

PO-10: Ability to communicate effectively on complex activities in engineering community and society.

PO-11: Ability to develop Project management principles and apply in various disciplinary environments.

PO-12: Recognition of the need for, and an ability to engage in life-long learning

Program Specific Outcomes(PSOs):

PSO-1: Graduates will interpret data and able to analyze digital and analog systems related to electrical and programming them.

PSO-2: Graduates will able to demonstrate, design and model electrical, electronic circuits, power electronics, power systems and electrical machines.

COURSE SYLLABUS

HIGH VOLTAGE ENGINEERING
(Professional Elective –IV)

Course Code: GR18A4021 **L:3 P:0 T:0 C:3**
IV year I semester

Unit -I
Breakdown in Gases
Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.

Unit – II
Breakdown in liquid and solid Insulating materials
Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Unit – III
Generation of High Voltages
Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Unit-IV
Measurements of High Voltages and Currents
Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Unit-V
High Voltage Testing of Electrical Apparatus and High Voltage Laboratories
Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Text Books
1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2015.
Reference Books
1. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.
2. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.

Gokaraju Rangaraju Institute of Engineering and Technology
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COURSE OBJECTIVES

Academic **Y**ear : 2022-23

Semester : I

Name of the Program: B.Tech Year: IV Section: A & B

Course/Subject: High Voltage Engineering Course Code: GR18A4021

Name of the Faculty: Vinay Kumar. A Dept. Electrical & Electronics Engineering

Designation: ASSOCIATE PROFESSOR.

At the end of the course the student is expected to

Objectives
1. Know the importance of high voltage engineering.
2. State the different dielectric materials and their break down mechanisms.
3. Acquire the knowledge of generation & measurement of high voltages and currents.
4. Impart the knowledge of insulation co-ordination.
5. Acquire the information on testing of electrical apparatus.

Signature of HOD Signature of faculty

Date: Date:

Note: Please refer to Bloom's Taxonomy, to know the illustrative verbs that can be used to state the objectives.

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COURSE OUTCOMES

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering Course Code: GR18A4021

Name of the Faculty : Vinay Kumar. A Dept. EEE

Designation: ASSOCIATE PROFESSOR.

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

Outcomes
1. Recall the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. Classify the different methods of breakdown mechanisms that occur on application of high voltages.
3. Elaborate the methods of generation of high voltages.
4. Distinguish the procedures for the measurement of D. C., A.C., & Impulse voltages.
5. Explain the various tests on H. V. equipment and on insulating materials.

Signature of HOD Signature of faculty

Date: Date:

Note: Please refer to Bloom's Taxonomy, to know the illustrative verbs that can be used to state the objectives.

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GRIET/DAA/1H/G/22-23 19 July 2022

Revised Academic Calendar
Academic Year 2022-23

IV B.Tech –First Semester

S. No.	EVENT	PERIOD	DURATION
1	Commencement of First Semester class work	04-07-2022	
2	I Spell of Instructions	04-07-2022 to 03-09-2022	9 Weeks
3	I Mid-term Examinations	05-09-2022 to 07-09-2022	3 Days
4	II Spell of Instructions	08-09-2022 to 11-11-2022	9 Weeks
5	II Mid-term Examinations	14-11-2022 to 16-11-2022	3 Days
6	Preparation	17-11-2022 to 23-11-2022	1 Week
7	End Semester Examinations (Theory/ Practical) Regular/ Supplementary	24-11-2022 to 14-12-2022	3 Weeks
8	Commencement of Second Semester, AY 2022-23	16-12-2022	

IV B.Tech – Second Semester

S. No.	EVENT	PERIOD	DURATION
1	Commencement of Second Semester class work	16-12-2022	
2	I Spell of Instructions	16-12-2022 to 13-02-2023	9 Weeks
3	I Mid-term Examinations	14-02-2023 to 16-02-2023	3 Days
4	II Spell of Instructions	17-02-2023 to 26-04-2023	10 Weeks
5	II Mid-term Examinations	27-04-2023 to 29-04-2023	3 Days
6	Preparation & Summer Vacation	01-05-2023 to 13-05-2023	2 Weeks
7	End Semester Examinations (Theory/ Practical) Regular / Supplementary	15-05-2023 to 03-06-2023	3 Weeks

Dean Academic Affairs

Copy to Principal, All HoDs, CoE

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

TIME TABLE

Gokaraju Rangaraju Institute of Engineering and Technology

Department of Electrical and Electronics Engineering

GRIET/PRIN/06/G/01/22-23 — **Wef : 13th June 2022**

BTech - EEE - A — **IV Year - I Semester**

DAY/ HOUR	10:20-11:15	11:15-12:10	12:10-01:05	01:05-01:40	01:40-02:30	02:30-03:20	03:20-04:10
MONDAY	HVE		ED	BREAK	PS-III		RB/DBMS
TUESDAY	PS-III		RB/DBMS		ED Lab/PW-I		
WEDNESDAY	PS-III	EHV			HVE		-
THURSDAY	ED		RB/DBMS		PW-I/ED Lab		
FRIDAY	RB/DBMS		Mentoring		EHV		HVE
SATURDAY	EHV	ED			PW-I		

ROOM NO	
Theory/Tutorial	4404
Lab	MP Phase I - 4404 ED Lab - 4407
Class Incharge:	M. N. Sandhya Rani

Course Code	Course Name	Faculty Code	Faculty Name (Emp ID)
GR18A4012	Power Systems-III (PS-III)	Dr PSVD	Dr. P. Srividya Devi (931)
GR18A4013	Electroncis Design (ED)	Dr DSNM	Dr. D. S. Naga Malleswara Rao (1598)
GR18A4014	Electrical and Hybrid Vehicles (EHV)	DSR	D. Srinivasa Rao (1540)
GR18A4021	High Voltage Engineeering (HVE)	AVK	A Vinay Kumar (881)
GR18A4022	Electronic Design Lab (ED Lab)	VUR/ DKK	V. Usharani/ D. Karuna Kumar (1045/760)
GR18A4061	Project Work Phase - I (PW-I)	AVK/DSR	A. Vinay Kumar/D Srinivasa Rao (881/1540)
GR18A4079/ GR18A2068	Robotics (RB)/ Data Base Management System (DBMS)	Dr. AAL/DS	Dr. A. Anitha Lakshmi (AAL) (944)/ D. Swathi (1681)

Almanac	
1st Spell of Instructions	13-06-2022 to 06-08-2022
1st Mid-term Examinations	08-08-2022 to 11-08-2022
2nd Spell of Instructions	12-08-2022 to 06-10-2022
2nd Mid-term Examinations	07-10-2022 to 11-10-2022
Preparation	12-10-2022 to 18-10-2022
End Semester Examinations (Theory/ Practicals) Regular / Supplementary	19-10-2022 to 08-11-2022

Time Table Coordinator — **HOD** — **DAA**

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GUIDELINES TO STUDY THE COURSE

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering Course Code: 57106

Name of the Faculty : Vinay Kumar.A Dept.: EEE

Designation : ASSOCIATE PROFESSOR.

Guidelines to study the Course/ Subject:

Course Design and Delivery System (CDD):

- The Course syllabus is written into number of learning objectives and outcomes.
- These learning objectives and outcomes will be achieved through lectures, assessments, assignments, experiments in the laboratory, projects, seminars, presentations, etc.
- Every student will be given an assessment plan, criteria for assessment, scheme of evaluation and grading method.
- The Learning Process will be carried out through assessments of Knowledge, Skills and Attitude by various methods and the students will be given guidance to refer to the text books, reference books, journals, etc.

The faculty be able to –

- Understand the principles of Learning
- Understand the psychology of students
- Develop instructional objectives for a given topic
- Prepare course, unit and lesson plans
- Understand different methods of teaching and learning
- Use appropriate teaching and learning aids
- Plan and deliver lectures effectively
- Provide feedback to students using various methods of Assessments and tools of Evaluation
- Act as a guide, advisor, counselor, facilitator, motivator and not just as a teacher alone

Signature of HOD Signature of faculty
Date: Date:

COURSE SCHEDULE

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section: A

Course/Subject : High Voltage Engineering Course Code: GR18A4021

Name of the Faculty : Vinay Kumar.A Dept.: EEE

Designation : ASSOCIATE PROFESSOR.

The Schedule for the whole Course / Subject is:

S. No.	Description	Duration (Date)		Total No. Of Periods
		From	To	
1.	Breakdown in Gases	04/07/2022	27/07/2022	**12**
2.	Breakdown in liquid and solid Insulating materials	01/08/2022	19/08/2022	**12**
3.	Generation of High Voltages	22/08/2022	05/09/2022	**14**
4.	Measurements of High Voltages and Currents	28/09/2022	28/09/2022	**14**
5.	High Voltage Testing of Electrical Apparatus and High Voltage Laboratories	30/09/2022	09/11/2022	**14**

Total No. of Instructional periods available for the course: **66** Periods

COURSE SCHEDULE

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section: B

Course/Subject : High Voltage Engineering Course Code: GR18A4021

Name of the Faculty : Vinay Kumar.A Dept.: EEE

Designation : ASSOCIATE PROFESSOR.

The Schedule for the whole Course / Subject is:

S. No.	Description	Duration (Date)		Total No. Of Periods
		From	To	
1.	Breakdown in Gases	05/07/2022	27/07/2022	**12**
2.	Breakdown in liquid and solid Insulating materials	02/08/2022	17/08/2022	**12**
3.	Generation of High Voltages	23/08/2022	06/09/2022	**14**
4.	Measurements of High Voltages and Currents	07/09/2022	27/09/2022	**14**
5.	High Voltage Testing of Electrical Apparatus and High Voltage Laboratories	28/09/2022	08/11/2022	**14**

Total No. of Instructional periods available for the course: **66** Periods

COURSE PLAN

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section : A

Course/Subject : High Voltage Engineering Course Code : GR18A4021

Name of the Faculty : Vinay Kumar.A Dept. : EEE

Designation : ASSOCIATE PROFESSOR.

Sl. No.	Unit No.	Date	Topics
1.	1	04/07/2022	Ionization processes and de-ionization processes
2.	1	06/07/2022	Types of Discharge
3.	1	08/07/2022	Gases as insulating Materials
4.	1	18/07/2022	Breakdown in Uniform gap
5.	1	20/07/2022	non-uniform gaps
6.	1	22/07/2022	Townsend's theory
7.	1	25/07/2022	Stream mechanism
8.	1	27/07/2022	Corona discharge
9.	2	01/08/2022	Breakdown in pure and commercial liquids
10.	2	03/08/2022	Solid dielectrics
11.	2	05/08/2022	composite dielectrics
12.	2	08/08/2022	intrinsic breakdown
13.	2	10/08/2022	electromechanical breakdown
14.	2	12/08/2022	thermal breakdown
15.	2	17/08/2022	Partial discharge
16.	2	19/08/2022	applications of insulating materials
17.	3	22/08/2022	Generation of high voltages
18.	3	24/08/2022	generation of high D. C. voltages

19.	3	26/08/2022	generation of high A.C. voltages
20.	3	29/08/2022	generation of impulse voltages
21.	3	02/09/2022	generation of impulse currents
22.	3	05/09/2022	tripping and control of impulse generators
23.	4	07/09/2022	Peak voltage
24.	4	09/09/2022	impulse voltage measurement method
25.	4	12/09/2022	high direct current measurement method
26.	4	14/09/2022	cathode ray oscillographs for impulse voltage measurement
27.	4	16/09/2022	cathode ray oscillographs for impulse current measurement
28.	4	19/09/2022	measurement of dielectric constant
29.	4	23/09/2022	measurement of loss factor,
30.	4	28/09/2022	partial discharge measurements
31.	5	30/09/2022	Various standards for HV Testing of electrical apparatus
32.	5	10/10/2022	IS, IEC standards
33.	5	12/10/2022	Testing of insulators
34.	5	14/10/2022	Testing of bushings
35.	5	17/10/2022	testing of isolators
36.	5	19/10/2022	testing of circuit breakers
37.	5	21/10/2022	testing of cables
38.	5	26/10/2022	Power transformers
39.	5	28/10/2022	some high voltage equipment
40.	5	31/10/2022	High voltage laboratory layout
41.	5	02/11/2022	indoor laboratories
42.	5	04/11/2022	outdoor laboratories
43.	5	07/11/2022	testing facility requirements
44.	5	09/11/2022	safety precautions in H. V. Labs.

Text Books & Reference Books:

Book 1: High Voltage Engineering by M.S. Naidu & V. Kamaraju – TMH Publishers 3rd Edition
Book 2: High Voltage Engineering : Fundamentals by E. Kuffel, W.S. Zaengl, J. Kuffel by Elsevier. 2nd Edition
Book 3: High Voltage Engineering by C.L. Wadhwa, New Age International (P) Limited, 1997
Book 4: High Voltage Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.

Signature of HOD

Signature of faculty

Date:

Date:

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

COURSE PLAN

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section : B

Course/Subject : High Voltage Engineering Course Code : GR18A4021

Name of the Faculty : Vinay Kumar.A Dept. : EEE

Designation : ASSOCIATE PROFESSOR.

Sl. No.	Unit No.	Date	Topics
1.	1	05/07/2022	Ionization processes and de-ionization processes
2.	1	06/07/2022	Types of Discharge
3.	1	09/07/2022	Gases as insulating Materials
4.	1	19/07/2022	Breakdown in Uniform gap
5.	1	20/07/2022	non-uniform gaps
6.	1	23/07/2022	Townsend's theory
7.	1	26/07/2022	Stream mechanism
8.	1	27/07/2022	Corona discharge
9.	2	02/08/2022	Breakdown in pure and commercial liquids
10.	2	03/08/2022	Solid dielectrics
11.	2	06/08/2022	composite dielectrics
12.	2	09/08/2022	intrinsic breakdown
13.	2	10/08/2022	electromechanical breakdown
14.	2	13/08/2022	thermal breakdown
15.	2	16/08/2022	Partial discharge
16.	2	17/08/2022	applications of insulating materials
17.	3	23/08/2022	Generation of high voltages

18.	3	24/08/2022	generation of high D. C. voltages
19.	3	27/08/2022	generation of high A.C. voltages
20.	3	30/08/2022	generation of impulse voltages
21.	3	03/09/2022	generation of impulse currents
22.	3	06/09/2022	tripping and control of impulse generators
23.	4	07/09/2022	Peak voltage measurement
24.	4	10/09/2022	impulse voltage measurement method
25.	4	13/09/2022	high direct current measurement method
26.	4	14/09/2022	cathode ray oscillographs for impulse voltage measurement
27.	4	20/09/2022	cathode ray oscillographs for impulse current measurement
28.	4	21/09/2022	measurement of dielectric constant
29.	4	24/09/2022	measurement of loss factor,
30.	4	27/09/2022	partial discharge measurements
31.	5	28/09/2022	Various standards for HV Testing of electrical apparatus
32.	5	11/10/2022	IS, IEC standards
33.	5	12/10/2022	Testing of insulators
34.	5	15/10/2022	Testing of bushings
35.	5	18/10/2022	testing of isolators
36.	5	19/10/2022	testing of circuit breakers
37.	5	22/10/2022	testing of cables
38.	5	25/10/2022	Power transformers
39.	5	26/10/2022	some high voltage equipment
40.	5	29/10/2022	High voltage laboratory layout
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42.	5	02/11/2022	outdoor laboratories
43.	5	05/11/2022	testing facility requirements
44.	5	08/11/2022	safety precautions in H. V. Labs.

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Book 2: High Voltage Engineering : Fundamentals by E. Kuffel, W.S. Zaengl, J. Kuffel by Elsevier. 2nd Edition
Book 3: High Voltage Engineering by C.L. Wadhwa, New Age International (P) Limited, 1997
Book 4: High Voltage Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.

Signature of HOD
Date:

Signature of faculty
Date:

Mapping of COs and Pos

Course Outcomes-Program Outcomes (POs) Relationship Matrix

P-Outcomes / C-Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
1	M	M	H		M			M	M	M	M	M	M	H
2	M	M	H		M			M	M	M	M	M	M	H
3	M	M	M	M	M	M	M	M	M	M	M	M	M	H
4	H	M			M						M		M	
5	H	M			M						M		M	

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

ASSIGNMENT SHEET – 1

Academic Year : 2022-23 Date: 10/08/2022

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering

Name of the Faculty : Vinay Kumar. A Dept. EEE

Designation : ASSOCIATE PROFESSOR.

This Assignment corresponds to Unit No. 1 & 2.

1. Explain how the breakdowns of gases occur in non-uniform fields? What is Arc discharge and Corona discharge? Explain in detail.
2. Derive an expression for current growth in gaseous medium due to primary and secondary ionization processes of Townsend's mechanism.
3. State and explain Paschen's law and derive an expression for the minimum `pd' value of the Paschen's curve from the first principles.
4. List out various electrical properties of dielectric materials and explain stressed oil volume theory in detail.
5. What are the different breakdown mechanisms that are occurs in solid dielectrics? Explain anyone.

Please write the Questions / Problems / Exercises which you would like to give to the students and also mention the Objectives/Outcomes to which these Questions / Problems / Exercises are related.

Outcome Nos.: 1, 2

Signature of HOD Signature of faculty

Date: Date:

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

ASSIGNMENT SHEET – 2

Academic Year : 2022-23 Date: 05/09/2022

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering

Name of the Faculty : Vinay Kumar. A Dept. EEE

Designation : ASSOCIATE PROFESSOR.

This Assignment corresponds to Unit No. 2 & 3.

1. What are treeing and tracking? Explain clearly the two processes in solid dielectrics.
2. State Paschen's law and explain about its Paschen's curve.
3. Derive an expression for the minimum `pd' value of the Paschen's curve from the first principles.
4. Explain how the breakdowns of gases occur in non-uniform fields. What is Arc discharge? Explain.
6. Explain the applications of solid insulation in
   a. Power transformers.
   b. Power capacitors.
7. Explain and compare the performance of the half-wave rectifier and voltage doubler circuits for the generation of high DC voltages with the voltage waveforms.
8. Explain with neat sketches the principle and operation of Cockroft-Walton voltage multiplier circuit

Please write the Questions / Problems / Exercises which you would like to give to the students and also mention the Objectives/Outcomes to which these Questions / Problems / Exercises are related.

Outcome Nos.: 2,3

Signature of HOD Signature of faculty

Date: Date:

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

ASSIGNMENT SHEET – 3

Academic Year : 2022-23 Date: 01/10/2022

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering

Name of the Faculty : Vinay Kumar. A Dept. EEE

Designation : ASSOCIATE PROFESSOR.

This Assignment corresponds to Unit No. 3 & 4.

1.	What is CVT? Explain how it can be used for measurement of high voltages?
2.	Explain the principle and operation of generating voltmeters for measurement of high DC voltages? Enumerate the advantages and disadvantages of the meters?
3.	What is the principle of Van de Graaff Generator? Explain in detail with a neat diagram.
4.	Explain the principle of operation of Marx Impulse Generator circuit with a neat diagram.
5.	What is Rogowski coil? Explain with a neat diagram its principle of operation for measurement of high impulse currents?
6.	What are the causes for switching and power frequency over voltages? How are they controlled in power systems?

Outcome Nos.: 3, 4

Signature of HOD Signature of faculty
Date: Date:

Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

ASSIGNMENT SHEET – 4

Academic Year : 2022-23 Date: 22/10/2022

Semester : I

Name of the Program : B.Tech Year: IV Section: A & B

Course/Subject : High Voltage Engineering

Name of the Faculty : Vinay Kumar. A Dept. EEE

Designation : ASSOCIATE PROFESSOR.

This Assignment corresponds to Unit No. 4,5.

1.	Draw a neat diagram of H.V. Schering bridge. Explain how to measure dielectric constant and loss angle of an insulator?
2.	Explain the different electrical tests done on isolators and circuits breakers.
3.	Describe the impulse current tests performed on lighting arrestors. How do you conclude that the arrester has passed the test?
4.	What are the significance of power factor tests and partial discharge tests on bushings? How are they conducted in the laboratory?
5.	Give the classification of High Voltage Laboratories and Explain in detail about the UHV Laboratories.
6.	a) Mention the different electrical tests done on isolators and circuit breakers. b) List the common test facilities available in high-voltage laboratories.

Outcome Nos.: 4,5.

Signature of HOD Signature of faculty

Date: Date:

Gokaraju Rangaraju Institute of Engineering and Technology
(Autonomous)

Bachupally, Kukatpally, Hyderabad – 500 090, TS

EVALUATION STRATEGY

Academic **Y**ear : 2022-23

Semester : I

Name of the Program : B.Tech Year: IV Section: A&B

Course : High Voltage Engineering

Name of the Faculty : Vinay Kumar.A Dept: EEE

Designation : Associate Professor.

1. TARGET:

A) Percentage for pass: 100%

b) Percentage of class: 85%

2. COURSE PLAN & CONTENT DELIVERY

Units/Lessons will be covered by lectures, presentations, exercises, solving numerical problems, demonstration of models and by assignments.

3. METHOD OF EVALUATION

3.1 Continuous Assessment Examinations (CAE-I, CAE-II)
3.2 Assignments

Signature of HOD Signature of faculty

Date: Date:

RUBRIC

OBJECTIVE: **Work effectively with others**

STUDENT OUTCOME: **Ability to function in a multi-disciplinary team.**

S.No.	Student Name	Performance Criteria	Unsatisfactory	Developing	Satisfactory	Exemplary	Score
			1	2	3	4	
1.	Suchismita Das	**Research & Gather Information**	Does not collect any information that relates to the topic.	Collects very little information--some relates to the topic	Collects some basic information--most relates to the topic.	Collects a great deal of information--all relates to the topic.	3
		Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.	3
		Share Equally	Always relies on others to do the work.	Rarely does the assigned work--often needs reminding.	Usually does the assigned work--rarely needs reminding.	Always does the assigned work without having to be reminded.	4
		Listen to other team mates	Is always talking--never allows anyone else to speak.	Usually doing most of the talking--rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.	4
						Average score	3.5

2.	Prasanthi V	**Research & Gather Information**	Does not collect any information that relates to the topic.	Collects very little information--some relates to the topic	Collects some basic information--most relates to the topic.	Collects a great deal of information--all relates to the topic.	4
		Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.	4
		Share Equally	Always relies on others to do the work.	Rarely does the assigned work--often needs reminding.	Usually does the assigned work--rarely needs reminding.	Always does the assigned work without having to be reminded.	4
		Listen to other team mates	Is always talking--never allows anyone else to speak.	Usually doing most of the talking--rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.	4
						Average score	4
3.	Venkatesh G	**Research & Gather Information**	Does not collect any information that relates to the topic.	Collects very little information--some relates to the topic	Collects some basic information--most relates to the	Collects a great deal of information--all relates to the topic.	3

					topic.		
		Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.	3
		Share Equally	Always relies on others to do the work.	Rarely does the assigned work--often needs reminding.	Usually does the assigned work--rarely needs reminding.	Always does the assigned work without having to be reminded.	3
		Listen to other team mates	Is always talking--never allows anyone else to speak.	Usually doing most of the talking--rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.	4
						Average score	3.25

ILLUSTRATIVE VERBS FOR STATING INSTRUCTIONAL OBJECTIVES

These verbs can also be used while framing questions for Continuous Assessment Examinations as well as for End – Semester (final)Examinations

ILLUSTRATIVE VERBS FOR STATING GENERAL OBJECTIVES/OUTCOMES

Know	**Understand**	**Design**

ILLUSTRATIVE VERBS FOR STATING SPECIFIC OBJECTIVES/OUTCOMES:

A. COGNITIVE DOMAIN (KNOWLEDGE)

1	2	3	4	5	6
Knowledge	**Comprehension Understanding**	**Application of knowledge & comprehension**	**Analysis Of whole w .r.t. its constituents**	**Synthesis**	**Evaluation Judgment**
Define **Identify**	**Convert** **Describe (a Procedure)** **Distinguish** **Explain why/how**	**Demonstrate** **Prepare** **Relate** **Show** **Solve**	**Differentiate** **Discriminate** **Distinguish** **Separate**	**Categorize** **Combine** **Design** **Generate** **Plan**	**Compare**

B. AFFECTIVE DOMAIN (ATTITUDE)		**C. PSYCHOMOTOR DOMAIN (SKILLS)**				
Assist	**Select**	**Bend**	**Dissect**	**Insert**	**Perform**	**Straighten**
Change	**Develop**	**Calibrate**	**Draw**	**Keep**	**Prepare**	**Strengthen**
		Compress	**Extend**	**Elongate**	**Remove**	**Time**
		Conduct	**Feed**	**Limit**	**Replace**	**Transfer**
		Connect	**File**	**Manipulate**	**Report**	**Type**
		Convert	**Grow**	**Move Precisely**	**Reset**	**Weigh**
		Decrease	**Increase**	**Paint**	**Set**	

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
(Autonomous)
Department of Electrical and Electronics Engineering

Academic Year: **2022-23**
Year: **IV**
Semester: **I**

MID Exam – I (Descriptive)
High Voltage Engineering
Subject Code: GR18A4021

Date: **06-09-2022**
Duration: **90 min**
Max Marks: **15M**

Note: Answer any THREE questions. All questions carry equal marks.

1.	a) What is meant by ionization, Explain the Breakdown procedure in gaseous dielectrics? b) State Paschen's law and explain about its Paschen's curve.	CO1	BL1, BL2
2.	Derive an expression for current growth in gaseous medium due to primary and secondary ionization processes of Townsend's mechanism.	CO2	BL4
3.	Explain the application of solid insulation in a) Power transformers. b) Power capacitors.	CO2	BL3
4.	What is the principle of operation of the Cockcroft-Walton voltage multiplier circuit? Explain with neat sketches.	CO3	BL4

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MID Exam – I (Objective)
High Voltage Engineering
Subject Code: GR18A4021

Date: **06-09-2022**
Duration: **10 min**
Max Marks: **5M**

Roll No: | | | | | | | | | | |

Note: Answer ALL questions. All questions carry equal marks.

1.	The sparking potential across a spark gap in a gaseous medium is a function of A) the gas pressure alone B) the gas length alone C) the ratio of gas pressure to gap length D) the product of gas pressure and gap length	CO1 BL1	[ ]
2.	If E_r is radial field due to space charge and E_0 the externally applied field, the transformation of avalanche into Streamer takes place when_____ A) $E_r < E_0$ B) $E_r > E_0$ C) $E_r = E_0$ D) (a) and (c)	CO1 BL2	[ ]
3.	Paschen's Law defines the breakdown strength in terms of A) voltage and current B) pressure of the gas and distance b/w Electrodes C) Density of the gas and distance b/w Electrodes D) all the above	CO1 BL1	[ ]
4.	The most used liquid for transformer insulation is a) Mineral oil b) Askerals c) Silicone oil d) Polyester oils	CO1 BL1	[ ]
5.	A liquid insulant apart from insulation act, works as a good coolant because of___ a) Being denser than a gas b) ability to fill the complete volume to be insulated c) high heat transfer ability d) higher dielectric strength	CO2 BL2	[ ]
6.	Partial discharge of a solid dielectric is due to____ *a)* Presence of impurities b) presence of air bubbles or voids c) use of low quality impregnates d) defects in manufacturing	CO2 BL1	[ ]
7.	The mechanism responsible for dielectric loss in a solid dielectric is/are ____ a) conduction b) polarization c) optical method d) all the above.	CO2 BL1	[ ]
8.	The material used for insulation that is exposed to atmosphere is a) Ceramics and glass b) polyesters c) Inorganic insulation d) rubber & plastic	CO2 BL2	[ ]
9.	If the cascaded voltage doubler circuit is operated for 4 stages with input voltage of $500V_{max}$, what will be the output voltage? a) 2 kV b) 4 kV c) 20kV d) 40 kV	CO3 BL2	[ ]
10.	The arrangement of cascaded voltage doubler circuit will be cumbersome of the level of steps increases beyond ____ a) 2 b) 4 c) 6 d) 8	CO3 BL2	[ ]

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Academic Year: **2022-23**
Year: **IV**
Semester: **I**

MID Exam – II (Descriptive)
High Voltage Engineering
Subject Code: GR18A4021

Date: **15-11-2022**
Duration: **90 min**
Max Marks: **15**

Note: Answer any THREE questions. All questions carry equal marks.

1.	Give the Marx circuit arrangement for multistage impulse generators. How is the basic arrangement modified to accommodate the wave time control resistances?	5M	BL2	CO3
2.	Describe, with a neat sketch, the working of a Van de Graaff generator. What are the factors that limit the maximum voltage obtained?	5M	BL3	CO3
3.	Write a brief note about the Hall-Generator with a neat diagram.	5M	BL4	CO4
4.	a) Mention the different electrical tests done on isolators and circuit breakers.	2M	BL4,	CO5
	b) List the common test facilities available in high-voltage laboratories.	3M	BL3	CO5

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Academic Year: **2022-23**
Year: **IV**
Semester: **I**

MID Exam – II (Objective)
High Voltage Engineering
Subject Code: GR18A4021

Date: **15-11-2022**
Duration: **10 min**
Max Marks: **5M**

Roll No: | | | | | | | | | | |

Note: Answer ALL questions. All questions carry equal marks.

1. In a voltage doubler circuit peak to peak ripple is if *C*: capacitance, *I* : load current, and *f* (frequency) = _____ [ ] CO3 BL2
(a) = $(3I_f/C)$ (b) = $2I_f/fC$ (c) = $3I/fC$ (d) = I/fC

2. In testing with a resonant transformer, the output voltage is [ ] CO3 BL2
(a) rectangular wave (b) triangular wave
(c) trapezoidal wave (d) pure sine wave

3. Tesla coil is used for [ ] CO3 BL2
(a) generation of sinusoidal output voltages
(b) generation of very high voltages
(c) generation of rectangular voltages
(d) generation of high frequency ac voltages

4. Time to front of a impulse voltage wave-form is defined as [ ] CO4 BL2
(a) 1.25 times the interval between 0.1 to 0.9 of peak value
(b) time interval between 0.1 to 0.9 of peak value
(c) 1.67 times the interval between 0.1 to 0.9 of peak value
(d) 1.25 times the interval between 0.3 to 0.9 of peak value.

5. The peak value of lightning stroke currents is of the order [ ] CO4 BL2
(a) 100 A (b) 1000 A (c) 10 to 100 kA (d) 10^6A

6. Switching overvoltage in power system networks are of the order of [ ] CO BL2
(a) 1.5pu (b) 2.5to3.5pu (c) 5 pu (d) 10 pu or more

7. The equivalent circuit of a surge arrester may be represented as: [ ] CO5 BL1
(a) capacitor (b) an inductor (c) non-linear resistor (d) resistor

8. Most important tests conducted on isolators and circuit breakers are [ ] CO5 BL2
(a) voltage withstand tests (b) short circuit tests
(c) high current tests (d) temperature rise tests.

9. The salt-fog test done on insulators is [ ] CO5 BL2
(a) impulse test (b) power frequency pollution test
(c) impulse current test (d) switching surge test

10. Impulse testing of transformers indicates [ ] CO5 BL2
(a) winding to ground insulation strength
(b) winding to winding insulation strength
(c) dielectric strength, quantity of insulation and processing
(d) induced voltages in other windings during transients

CODE: GR18A4021	GR18	SET - 2

IV B.Tech I Semester Regular Examinations, Dec/Jan 2021/22
HIGH VOLTAGE ENGINEERING
(Electrical and Electronics Engineering)

Time: 3 hours **Max Marks: 70**

Instructions:

1. Question paper comprises of **Part-A** and **Part-B**
2. **Part-A** (for 20 marks) must be answered at one place in the answer book.
3. **Part-B** (for 50 marks) consists of **five questions with internal choice,** answer all questions.

PART – A

(Answer ALL questions. All questions carry equal marks)

10 * 2 = 20 Marks

1. a.	Write the Paschen's law.	**[2]**
b.	What is 'thermal breakdown' in solid dielectrics?	**[2]**
c.	What are the requirement of gases for insulation purposes?	**[2]**
d.	Define the elastic collision & inelastic collision.	**[2]**
e.	Draw the circuit for producing impulse voltage.	**[2]**
f.	Define withstand voltage.	**[2]**
g.	Draw the simple circuit of peak reading voltmeter and its equivalent.	**[2]**
h.	What is a mixed potential divider?	**[2]**
i.	Define flashover voltage.	**[2]**
j.	List the different power frequency tests on insulators.	**[2]**

PART – B

(Answer ALL questions. All questions carry equal marks)

5 * 10 = 50 Marks

2.	**(a)** Explain the Townsend's theory in detail.	**[10]**
	(b) What is meant by Corona discharge? Explain.	
	OR	
3.	**(a)** Discuss the ionization processes in gases.	**[10]**
	(b) Describe the various factors that influence breakdown in a gas.	
4.	**(a)** What are the characteristics of liquid dielectrics?	**[10]**
	(b) Explain the phenomena of electrical conduction in liquids.	
	OR	
5.	**(a)** What are commercial liquid dielectrics, and how are they different from pure liquid dielectrics?	**[10]**
	(b) Discuss the effect of the following parameters on the breakdown strength of liquids: (i) Hydrastatic pressure (ii) Solid impurities (iii) Moisture content in the oil.	
6.	**(a)** Describe, with a neat sketch, the working of a Van de Graaff generator.	**[10]**
	(b) Explain the different schemes for cascade connection of transformers for producing very high ac voltages.	
	OR	

7. **(a)** Why is a Cockcroft-Walton circuit preferred for voltage multiplier circuits? **[10]**
(b) Give the expression for ripple and regulation in voltage multiplier circuits.

8. **(a)** Describe the principle of operation of an Electrostatic Voltmeter. **[10]**
(b) Discuss the different methods of measuring high dc voltages.

OR

9. **(a)** Why are capacitance voltage dividers preferred for high ac voltage measurements? **[10]**
(b) With a neat diagram explain the method for impulse voltage measurement using cathode ray oscillographs.

10. **(a)** Mention the different electrical tests done on isolators and circuit breakers. **[10]**
(b) What is an operating duty cycle test on a surge arrester? Why is it more significant than other tests?

OR

11. **(a)** What is the significance of impulse tests? Briefly explain the impulse testing of Insulators. **[10]**
(b) Discuss the safety precautions in H.V. Labs.

GR18 2022-23 B.Tech EEE 410 GR18A4021 High Voltage Engineering Sessional Marks

S.No	Roll No	MID-I Marks	MID-II Marks	Tutorial Marks	Assessment Marks	Sessional Marks
1	17241A0232	AB	AB	0	0	0
2	18241A0249	AB	AB	0	0	0
3	19241A0201	7	11	5	5	19
4	19241A0202	10	9	5	5	20
5	19241A0203	11	14	5	5	23
6	19241A0204	16	16	5	5	26
7	19241A0205	15	15	5	5	25
8	19241A0206	17	15	5	5	26
9	19241A0207	12	14	5	5	23
10	19241A0208	4	7	5	5	16
11	19241A0209	5	8	5	5	17
12	19241A0210	20	20	5	5	30
13	19241A0211	10	13	5	5	22
14	19241A0212	9	6	5	5	18
15	19241A0213	19	17	5	5	28
16	19241A0214	16	15	5	5	26
17	19241A0215	17	15	5	5	26
18	19241A0216	5	6	5	5	16
19	19241A0217	8	12	5	5	20
20	19241A0218	15	15	5	5	25
21	19241A0219	4	9	5	5	17
22	19241A0220	9	11	5	5	20
23	19241A0221	16	13	5	5	25
24	19241A0222	3	6	5	5	15
25	19241A0223	6	9	5	5	18
26	19241A0224	5	9	5	5	17
27	19241A0225	8	10	5	5	19
28	19241A0226	AB	7	5	5	14
29	19241A0227	13	12	5	5	23
30	19241A0228	5	6	5	5	16
31	19241A0229	14	12	5	5	23
32	19241A0230	5	5	5	5	15
33	19241A0231	12	11	5	5	22
34	19241A0232	6	8	5	5	17
35	19241A0233	13	10	5	5	22
36	19241A0234	7	9	5	5	18
37	19241A0235	17	12	5	5	25
38	19241A0236	17	17	5	5	27
39	19241A0237	4	5	5	5	15
40	19241A0238	6	3	5	5	15
41	19241A0239	7	9	5	5	18
42	19241A0240	16	17	5	5	27
43	19241A0241	12	9	5	5	21
44	19241A0242	7	9	5	5	18
45	19241A0243	18	17	5	5	28
46	19241A0244	15	17	5	5	26
47	19241A0246	8	6	5	5	17
48	19241A0247	17	17	5	5	27
49	19241A0249	11	11	5	5	21
50	19241A0250	15	14	5	5	25
51	19241A0251	16	17	5	5	27
52	19241A0252	18	17	5	5	28
53	19241A0253	16	17	5	5	27
54	19241A0254	6	9	5	5	18
55	19241A0255	16	17	5	5	27

56	19241A0256	4	8	5	5	16
57	19241A0257	14	11	5	5	23

58	19241A0258	17	17	5	5	27
59	19241A0259	AB	5	5	5	13
60	19241A0260	AB	8	5	5	14
61	19241A0261	13	15	5	5	24
62	19241A0262	9	12	5	5	21
63	19241A0263	10	13	5	5	22
64	19241A0264	4	10	5	5	17
65	19241A0265	8	6	5	5	17
66	19241A0266	6	12	5	5	19
67	19241A0267	12	16	5	5	24
68	19241A0268	7	10	5	5	19
69	19241A0269	18	16	5	5	27
70	19241A0270	11	AB	5	5	16
71	19241A0271	14	9	5	5	22
72	19241A0272	7	9	5	5	18
73	19241A0273	8	10	5	5	19
74	19241A0274	17	12	5	5	25
75	19241A0275	6	7	5	5	17
76	19241A0276	9	13	5	5	21
77	19241A0277	9	10	5	5	20
78	19241A0278	18	17	5	5	28
79	19241A0279	12	9	5	5	21
80	19241A0280	6	13	5	5	20
81	19241A0281	10	10	5	5	20
82	19241A0282	10	10	5	5	20
83	19241A0283	4	13	5	5	19
84	19241A0284	18	15	5	5	27
85	19241A0285	14	14	5	5	24
86	19241A0286	9	15	5	5	22
87	19241A0287	17	18	5	5	28
88	19241A0288	7	13	5	5	20
89	19241A0289	3	9	5	5	16
90	19241A0290	11	16	5	5	24
91	19241A0291	11	12	5	5	22
92	19241A0292	12	14	5	5	23
93	19241A0293	10	7	5	5	19
94	19241A0294	7	8	5	5	18
95	19241A0295	8	16	5	5	22
96	19241A0296	9	11	5	5	20
97	19241A0297	8	8	5	5	18
98	19241A0298	17	17	5	5	27
99	19241A0299	3	9	5	5	16
100	19241A02A0	AB	AB	0	0	0
101	19241A02A1	11	6	5	5	19
102	19241A02A2	AB	15	5	5	18
103	19241A02A3	3	6	5	5	15
104	19241A02A4	8	13	5	5	21
105	19241A02A5	17	12	5	5	25
106	19241A02A6	18	17	5	5	28
107	19241A02A7	11	10	5	5	21
108	20245A0201	10	13	5	5	22
109	20245A0202	12	11	5	5	22
110	20245A0203	14	10	5	5	22
111	20245A0204	15	16	5	5	26
112	20245A0205	15	16	5	5	26
113	20245A0206	6	AB	5	5	13
114	20245A0207	6	14	5	5	20
115	20245A0208	7	11	5	5	19
116	20245A0209	10	14	5	5	22
117	20245A0210	7	12	5	5	20
118	20245A0211	14	18	5	5	26
119	20245A0212	13	16	5	5	25

120	20245A0213	15	15	5	5	25
121	20245A0214	5	12	5	5	19
122	20245A0215	16	14	5	5	25
123	20245A0216	16	17	5	5	27
124	20245A0217	12	14	5	5	23
125	20245A0218	14	14	5	5	24
126	20245A0219	13	13	5	5	23
127	20245A0220	17	14	5	5	26
128	20245A0221	AB	10	5	5	15
129	20245A0222	6	9	5	5	18
130	20245A0223	10	12	5	5	21
131	20245A0224	6	11	5	5	19
132	20245A0225	9	10	5	5	20