Ref No:

< Sri Krishna Institute of Technology, Bangalore>



COURSE PLAN

Academic Year 2019-20

Program:	B E – Electrical and Electronics Engineering
Semester :	7
Course Code:	15EEL77
Course Title:	RELAY AND HIGH VOLTAGE LAB
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	Avinash S

Academic Evaluation and Monitoring Cell Sri Krishna Institute of Technology #29, Hesaraghatta Main Road Chimney Hills, Chikkabanavara Post Bangalore– 560090,Katakana, India. Phone / Fax :+91-STD-080 Web: skit.org.in, e-mail:

A. LABORATORY INFORMATION

1. Lab Overview

Degree:	B.Tech	Program:	EE
Year / Semester :	7/4	Academic Year:	2019-20
Course Title:	Relay and High Voltage Lab	Course Code:	15EEL77
Credit / L-T-P:	3 / 0-1-2	SEE Duration:	180 Minutes
Total Contact Hours:	30 Hrs	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	1 / Module
Course Plan Author:	Mr.Avinash S	Sign	Dt :
Checked By:		Sign	Dt :

2. Lab Content

Unit	Title of the Experiments	Lab	Concept	Blooms
		Hours	_	Level
1	Over Current Relay:	3	Analysis of	L4
	(a)Inverse Definite Minimum Time(IDMT)Non-Directional		over	Analyze
	Characteristics		current	
	(b) Directional Features		relay	
	(C) IDMT Directional.		Augusta	
2	IDMI Characteristics of Over Voltage or Under Voltage	3	Analysis of	L4
2	Characteria of Negative Seguence Polay	2		1.4
ر	operation of Negative Sequence Relay.	ر ا	Negative	L4
			Sequence	
			relav	
4	Operating Characteristics of Microprocessor Based	3	Analysis of	L4
	(Numeric) Over –Current Relay.		Mp over	
			current	
			relay	
5	Operating Characteristics of Microprocessor Based	3	Analysis of	L4
	(Numeric) Distance Relay.		Distance	
			relay	
6	Operating Characteristics of Microprocessor Based	3	Analysis of	L4
	(Numeric) Over/Under Voltage Relay.		Under	
			Voltage	
7	Concretion Protection.	2	relay	1.4
/	Generation Protection: Merz Price Scheme	5	Protection	L4
			system for	
			generating	
			component	
			S	
8	Feeder Protection against Faults.	3	Analysis of	L4
			Protection	
			system for	
			Feeder	
9	Motor Protection against Faults.	3	Analysis of	L4
			Protection	
			system for	
10			Motors	
10	Spark Over Characteristics of Air subjected to High	5	Breakdown	L4
	voltage AC with Spark voltage Corrected		mechanism	
11	Spark Over Characteristics of Air subjected to High	2	Broakdown	1.4
<u> </u>	voltade DC	5	mechanism	L4
			of dases	
12	Measurement of HVAC and HVDC using Standard	3	Breakdown	14
<u> </u>				- '

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	Spheres as per IS		mechanism	
			in air,	
13	Measurement of Breakdown Strength of Transformer Oil	3	Breakdown	L4
	as per IS		mechanism	
			of liquid ,	
14	Field Mapping using Electrolytic Tank for any one of the	3	Field	L4
	following Models: Cable/ Capacitor/		mapping	
	Transmission Line/ Sphere Gap.		analysis	
15	(a) Generation of standard lightning impulse voltage and	3	Generation	L4
	to determine efficiency and energy of		of Impulse	
	impulse generator. (b) To determine 50% probability		voltage and	
	flashover voltage for air insulation		current	
	subjected to impulse voltage.			

3. Lab Material

Unit	Details	Available
1	Text books	
	M.S. Naidu, V.Kamaraju McGraw Hill 5 th Edition, 2013.	In Lib
2	Reference books	
	E. Kuffel, W.S. Zaengl, J. Kuffel	In dept
3	Others (Web, Video, Simulation, Notes etc.)	
		Not Available

4. Lab Prerequisites:

-	-	Base Course:		-	-
SNo	Course	Course Name	Topic / Description	Sem	Remarks
	Code				
1	15EE73	Power system	Knowledge on protection systems	7	
		Protection			
			Knowledge of relays	-	

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

5. General Instructions

SNo	Instructions	Remarks
1	Keep the lab neatly.	
2	Maintain silence.	
3	Maintain your lab observation and lab manual.	
4	Prepare your experiment in well advance.	
5	Do not leave the lab without in-charge staff permission.	
6	Do not move around in the lab.	
7	Do not misplace the equipments.	
8	Check the power supply before use.	
9	Maintain discipline in the lab.	
10	After completion of your experiment switch off the power supply.	

6. Lab Specific Instructions

SNo	Specific Instructions	Remarks
1	The equipment must be connected firmly to the mother ground	
2	The electrodes must be cleaned properly before use	

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3	Before starting the experiment, make sure the electrodes a	are properly	
	aligned to zero reading		
4	Any part of the equipment should not be touched		
5	Do not enter High-Voltage area without discharge		
6	Sudden High-Voltage should not be applied to the specimen		
7	Do not enter the test-bay while the equipments are in operation	า	
8	Ignore the first one reading as the air between the electroc ionized	des may be	

B. OBE PARAMETERS

1. Lab / Course Outcomes

#	COs	Teach.	Concept	Instr	Assessment	Blooms'
		Hours		Method	Method	Level
1	Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type.	3	Analysis of Protection system for Feeder	Demons trate	Slip Test	L2
2	Experimentally verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.	3	Analysis of Protection system for Motors	Demons trate	Assignment	L2
3	Analyze the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages	3	Breakdown mechanism in air,	Demons trate	Assignment and Slip Test	L2
4	Analyze high AC and DC voltages and breakdown strength of transformer oil	03	Breakdown mechanism of gases,	Simulati on	Assignment	L3
5	Draw electric field and measure the capacitance of different electrode configuration models.	03	Breakdown mechanism in air,	Tutorial	Slip test	L2
6	Understand knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flash over voltage for air insulation	03	Breakdown mechanism of liquid ,	Tutorial	Assignment	L2
7	verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay	03	Field mapping analysis	Demons trate	Assignment and Slip Test	L3
8	Analyze high AC and DC voltages and breakdown phenomenon of air insulation	03	Generation of Impulse voltage and current	Demons trate	Assignment	L2
-	Total	24	-	-	-	-

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Lab Applications

SNo	Application Area	CO	Level
1	In power systems, varieties of insulation materials are used to protect the high		L2
	voltage power apparatus such as transformer, switchgear, current transformer,		
	potential transformer etc.		
2	The transformer oil is degraded due to the combination of the ageing processes	CO2	L2
	such as partial discharge (PDs), electrical arcing		
3	the effects of different ageing processes on the optical absorption properties of	CO3	L2
	insulating oil of a model transformer is studied using a UV-visible		
	spectrophotometer diagnostic method which is presently becoming a popular		
	method to identify the ageing of the insulating oil of high voltage transformers		

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4	High voltage (HV) power apparatus determines the stability c	of any electrical	CO4	L3
	power system	-		
5	Power Transformers are one of the most critical component of	oower system in	CO5	L2
	which mineral oil is used for both insulation and cooling pur	poses. It acts a		
	insulating medium between solid insulations like kraft paper, pres	sboard etc.		
6	The transformer oil is degraded due to the combination of the a	geing processes	CO6	L2
	such as partial discharge (PDs), electrical arcing			
7	the effects of different ageing processes on the optical absorpti	on properties of	C07	L3
/	insulating oil of a model transformer is studied using	a UV-visible		
	spectrophotometer diagnostic method which is presently becc	ming a popular		
	method to identify the ageing of the insulating oil of high voltage	transformers		
8	The transformer oil is degraded due to the combination of the a	geing processes	CO8	L2
	such as partial discharge (PDs), electrical arcing	0 0 1		

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO	PO1	PO1	PO1	Level							
			2	3	4	5	6	7	8	9	0	1	2	
15EEL77.1	Experimentally verify the	,												L3
	characteristics of over	X	X	X		X								
	current, over voltage,													
	under voltage and													
	negative sequence relays													
	static type													
	Static type.		V	V										14
15000//.2	characteristics of microprocessor													Ц4
	based over current over voltage													
	under voltage relays and distance													
	relay.													
15EEL77.3	Analyze the spark over	X		X	X	X								L3
	characteristics for both uniform													
	and non-uniform configurations	ġ												
	using High AC and DC voltages													
15EEL77.4	Analyze high AC and DC voltages	x	X	X		X								L3
	and breakdown strength of	1												
	transformer oil													
15EEL77.5	Draw electric field and measure	X	X	X		X								L2
	electrode configuration models	-												
15EEL 77.6	Show knowledge of generating		v			v								12
19222/7.0	standard lightning impulse voltage													LZ
	to determine efficiency, energy of	-												
	impulse generator and 50%													
	probability flash over voltage for													
	air insulation													
15EEL77.7	Experimentally verify the	X	X	Х		X								L3
	characteristics of microprocessor	-												
	based over current, over voltage,													
	under voltage relays and distance													
	relay													1 .
15EEL77.8	Analyze high AC and DC voltages	X	X			X								L4

COURSE PLAN - CAY 2019-20					BE-7-EE-SKIT-Ph5b1-F02-V2.2									
and breakdown phenomenon of														
air insulation										1				
CS501PC. Average														

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Mappi	ing	Mapping	Justification
		Level	
СО	PO	-	-
CO1	PO1	L2	Knowledge on Relay .
CO1	PO2	L4	Analyzing the performance characteristics under voltage and negative sequence relays
CO2	PO1	L2	Knowledge on microprocessor based over current, over voltage
CO2	PO2	L4	To analyze the performance characteristics of microprocessor based over current, over voltage
CO3	PO1	L2	Knowledge on
CO3	PO2	L4	To analyse the frequency domain reposes of a given second order system using discrete components.
CO4	PO1	L2	Knowledge on design of control systems
CO4	PO2	L4	To analyze Lead compensators for given specifications.
CO4	PO3	L6	Design and analyze Lead compensators for given specifications.
CO4	PO9	L3	Projects or internship on Lead compensator.
CO5	PO1	L2	Knowledge on design of control systems
CO5	PO2	L4	To analyze Lag compensators for given specifications.
CO5	PO3	L6	Design and analyze Lag compensators for given specifications.
CO5	PO9	L3	Projects or internship on Lag compensator.
CO6	PO1	L2	Knowledge on design of control systems
CO6	PO2	L4	To analyze Lag lead compensators for given specifications.
CO6	PO3	L6	Design and analyze Lag lead compensators for given specifications.
CO6	PO9	L3	Projects or internship on Lag Lead compensator.
CO7	PO1	L2	Knowledge on time domain analysis
CO7	PO2	L4	To analyse the time domain reposes of a given second order system using software package or discrete components.
CO7	PO5	L3	To determine frequency domain reposes of a given second order system using software package.
CO8	PO1	L2	Knowledge on design of control systems
CO8	PO2	L5	To analyze the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator) and Verifying the same by simulation.
CO8	PO5	L3	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response using software package.
CO8	PO9	L3	Projects or internship on Controllers.

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					

Note: Anything not covered above is included here.

15EEL77

C. COURSE ASSESSMENT

1. Course Coverage

Unit	nit Title Teachi No. of question in Exam								CO	Levels	
		ng	CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
		Hours									
1	Over Current Relay:	03	1	-	-	-	-	-	1	CO1	L2
	(a)Inverse Definite Minimum										
	Time(IDMT)Non-Directional										
	Characteristics										
	(b) Directional Features										
	(c) IDMT Directional.										
2	IDMT Characteristics of Over	03	1	-	-	-	-	-	1	CO2	L3
	Voltage or Under Voltage Relay										
	(Solid State or Electromechanical										
3	Operation of Negative Sequence	03	1	-	-	-	-	-	1	CO3	L3
	Relay.										
4	Operating Characteristics of	03	1	-	-	-	-	-	1	CO4	L3
	Microprocessor Based (Numeric)										
	Over –Current Relay.										
5	Operating Characteristics of	03	1	-	-	-	-	-	1	CO5	L4
	Microprocessor Based (Numeric)										
	Distance Relay.										
6	Operating Characteristics of	03	-	1	-	-	-	-	1	CO6	L4
	Microprocessor Based (Numeric)										
	Over/Under Voltage Relay.										
7	Generation Protection:	03	-	1	-	-	-	-	1	CO7	L4
	Merz Price Scheme.										
8	Feeder Protection against Faults.	03	-	1	-	-	-	-	1	CO8	L4
9	Motor Protection against Faults.	03	-	1	-	-	-	-	1	CO9	L4
10	Spark Over Characteristics of Air	03	-	1	-	-	-	-	1	CO10	L4
	subjected to High Voltage AC with										
	Spark Voltage Corrected										
	to Standard Temperature and										
	Pressure for Uniform										
11	Spark Over Characteristics of Air	03	-	-	1	-	-	-	1	CO11	L4
	subjected to High voltage DC.										
12	Measurement of HVAC and HVDC	03	-	-	1	-	-	-	1	CO12	L4
<u> </u>	using Standard Spheres as per IS										<u> </u>
13	Measurement of Breakdown	03	-	-	1	-	-	-	1	CO13	L3
	Strength of Transformer Oil as per										
										001	
14	Field Mapping Using Electrolytic	03	-	-	1	-	-	-	1	CO14	L4
	Haddeley Cable (Capacitor (
	Transmission Line (Cabara Car										
	rransmission Line/ Sphere Gap.										
<u> </u>	Total	<u> </u>	F	F	F	F	F	F	20		
		45	5	5	5	5)	5	20	-	-

Note: Write CO based on the theory course.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	СО	Levels
CIA Exam – 1	30	CO1, CO2, CO3, CO4	L23, L3
CIA Exam – 2	30	CO5, CO6, CO7,	L1, L2, L3
CIA Exam – 3	30	CO5, CO6,	L1, L2, L3
Assignment - 1	05	CO1, CO2, CO3, CO4	L2, L3, L4
Assignment - 2	05	CO5, CO6, CO7,	L1, L2, L3

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Assignment - 3	05	CO8,	L1, L2, L3				
Seminar - 1	05	CO1, CO2, CO3, CO4	L2, L3, L4				
Seminar - 2	05	CO5, CO6,	L2, L3, L4				
Seminar - 3	05	CO8,	L2, L3, L4				
Other Activities – define –		CO1	L2, L3, L4				
Slip test							
Final CIA Marks	40	-	-				
-							

SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	05 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	25 Marks
4	Internal Assessment	15 Marks
5	SEE	80 Marks
-	Total	100 Marks

D. EXPERIMENTS

Experiment 01 : Over Current Relay:

(a)Inverse Definite Minimum Time(IDMT)Non-Directional

Characteristics

(b) Directional Features

(c) IDMT Directional.

-	Experiment No.:	1	Marks		Date		Date						
					Planned		Conducted						
1	Title	Ove	er Current Re	lay									
2	Course Outcomes	To a	analyze the i	nverse Defini	ite minimum	Time charac	teristic						
3	Aim	lot	Ind Inverse L	Definite Minir	num Time(ID	MI)Non-Dire	ectional						
		(h) [Directional F	eatures									
		(c) II	IDMT Directional.										
4	Material /	1] E	Electro-mechanical over current relay.										
	Equipment Required	VRPS.											
		3] A	AC to DC supply.										
		4] T	imer.										
		5] P	atch Chords.										
5	Theory, Formula,												
6	Principle, Concept					in the circuit							
0	Activity Algorithm		1. Connect	Connections are made as shown in the circuit diagram.									
	Pseudo Code		2. Set a rec	quired PSM a	ind TSM in th	ie relay.							
			3. Ensure	time interval	. meter swite	ch is in TIM	position and	d Protection					
			timer sw	vitch in ON po	osition.								
			4. Keeping	the dimmer	in zero posit	ion switch or	n the mains.						
			5. Push tes	st start buttor	n, CB ON indi	icator, amme	eter will glow						
			6. Adjust tl	ne dimmer te	o test approx	kimate inject	ion current (Greater than					
			the test	relay current									
			7. Push tes	st stop/reset	button witho	out disturbing	g the dimme	er position.					
			8. Push te	st start butte	on, note dov	wn the curre	ent , time in	terval meter					
			starts up	o, counting o	ver current r	elay trip occ	urs and TRIF	indictor will					
			glow.										

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		9. 10	The above procedu	ire is once again re	neated for	/. or different values of
		10.	PSM and TSM		spealed R	of different values of
		11	Draw a graph of trip	time v/s fault curre	nt	
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	11.	Draw a graph of trip	time v/s fault curre	nt.	
8	Observation Table,		Holding ratio = Reset	value / Pick-up val	ue.	
8	Observation Table, Look-up Table,	PSM=	Holding ratio = Reset Amps	value / Pick-up val	ue.	
8	Observation Table, Look-up Table, Output	PSM= TSM=	Holding ratio = Reset Amps secs	value / Pick-up val	ue . TSM	1=secs
8	Observation Table, Look-up Table, Output –	PSM= TSM= Sl No	Holding ratio = Reset Amps secs Fault current in	value / Pick-up val	ue . TSM	1=secs Fault current in
8	Observation Table, Look-up Table, Output –	PSM= TSM= Sl No	Holding ratio = Reset Amps secs Fault current in Amps	Value / Pick-up val	ue . TSM Sl No	1=secs Fault current in Amps
8	Observation Table, Look-up Table, Output –	PSM= TSM= Sl No	Holding ratio = Reset Amps secs Fault current in Amps	Value / Pick-up val	ue . TSM Sl No	1=secs Fault current in Amps
8	Observation Table, Look-up Table, Output – –	PSM= TSM= SI No 1 2	Holding ratio = Reset Amps secs Fault current in Amps	value / Pick-up val Operating time in sec	ue . TSM Sl No	1=secs Fault current in Amps
8	Observation Table, Look-up Table, Output – – – –	PSM= TSM= Sl No	Holding ratio = Reset Amps secs Fault current in Amps	Value / Pick-up val	ue . TSM Sl No 1 2 3	f=secs Fault current in Amps
8	Observation Table, Look-up Table, Output - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps	Value / Pick-up val	ue . TSM SL No 1 2 3 4 5	f=secs Fault current in Amps
8	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= SI No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	value / Pick-up val	ue . TSM Sl No 1 2 3 4 5 ne setting	f=secs Fault current in Amps
8	Observation Table, Look-up Table, Output - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	Value / Pick-up val	ULE . TSM SL NO 1 2 3 4 5 ne setting	f=secs Fault current in Amps
8	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= SI NO 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	value / Pick-up val Operating time in sec ultiplier TSM-Tin	ULE . TSM SL NO 1 2 3 4 5 ne setting	f=secs Fault current in Amps
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	value / Pick-up val	ue . TSM Sl No 1 2 3 4 5 ne setting	fault current in Amps multiplier
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	Operating time in sec ultiplier TSM-Tin	ULE . TSM SL NO 1 2 3 4 5 ne setting	f=secs Fault current in Amps multiplier
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	Value / Pick-up val	ue . TSM SL No 1 2 3 4 5 ne setting	f=secs Fault current in Amps
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	value / Pick-up val	ue . TSM SL No 1 2 3 4 5 ne setting	f=secs Fault current in Amps multiplier
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	Value / Pick-up val	ue . TSM SLNO 1 2 3 4 5 ne setting	f=secs Fault current in Amps multiplier
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	value / Pick-up val	ue . TSM SL No 1 2 3 4 5 ne setting	fault current in Amps multiplier
8 9 10	Observation Table, Look-up Table, Output - - - - - - - - - - - - - - - - - - -	PSM= TSM= Sl No 1 2 3 4 5	Holding ratio = Reset Amps secs Fault current in Amps PSM-Plug setting m	Value / Pick-up val	ULE . TSM SL NO 1 2 3 4 5 ne setting	f=secs Fault current in Amps multiplier

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			different plug	ing multipli	multiplier (PSM) and time setting multiplier (TSM) and							
	also determine the pick- up current, drop-off (reset) current and holding ratio											
12	Applicatior	n Areas	Used	to	protected	highly	sensitive	and	high	rating	electrical	
			equipr	nen	its							
13	Remarks											
14	Faculty	Signature	1									
	with Date	-										

Experiment 02 : MICROCONTROLLER BASED OVER CURRENT RELAY

_	Experiment No	1	Marks		Date		Date	
			1 Idirito		Planned		Conducted	
1	Title		MIC		LLER BASED C	OVER CUR	RENT RELAY	, ,
2	Course Outcomes							
3	Aim	To ol	btain opera	ational chara	cteristic of µP	based ove	er current re	lay and also
1	Material /	uelei		ick-up and t	arop on current	ι.		
4	Equipment Required	µP ba	ased over c	urrent relay	module, Patch	chords		
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code							
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table,	•	PSM =	Amps				
	Look-up Table, Output	TSM	=			TSM =		
	_	Sl No	Load	current in	Operating t	ime Sl N	o Load	current in
			Amps		in sec		Amps	
	-	1				1		
	-	2				2		
	-	3				3		
	_	4				4		
	-	5				5		
	-	6				6		
	_	7				7		
	-							
11	Results & Analysis							
12	Application Areas		Used to	protect high	ly sensitive and	d high ratir	ng electrical e	equipments
13	Remarks							
14	Faculty Signature with Date							

Experiment 03 : ESTIMATION OF BREAKDOWN STRENGTH OF TRANSFORMER OIL

-	Experiment No.:	1	Marks		Date	;		Date		-
					Planne	ed		Conducted	k	
1	Title	ES	FIMATION OF	F BREAKDOV	WN STRE	ENGTI	H OF TRANS	SFORMER (DIL	
2	Course Outcomes	То	analyze the k	oreak-down	strenght	of tra	insformer oi	l		
3	Aim	То	determine	breakdown	voltage	and	breakdown	strength	of the	given
		trar	nsformer oil							
4	Material /	Ob	servation							

	COURSE PLAN - CAY	2019-20 BE-7-EE-SKIT-Ph5b1-F02-V2.2	
	Equipment Required	Manual	
		Testing oil test kit, Transformer oil	
5	Theory, Formula, Principle, Concept		
6	Procedure, Program, Activity, Algorithm, Pseudo Code	 Connections are made as per the circuit diagram. The electrodes in the oil test cup is adjusted for the required distance. 80% of the transformer oil is filled in the oil container cup. 	
		4. Keep the oil container cup on the HV transformer bushings.	
		5. Close the top door and bring the variac to minimum position.	
		6. Switch ON the mains and press the HT push button, the HT ON indicato	r
		will glow and	
		UNIT READY indicator will also glow.	
		7. Now gradually increase the voltage until the breakdown occurs.	
		8. Note down the breakdown voltage in the voltmeter by pressing	a
		MEMORY push button.	-
		9. Bring the variac to minimum position and switch OFF the main supply	
		10 Repeat the same procedure and note down 2 to 4 breakdown voltages	
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	Control panel Control panel Control panel GokV A.C. Supply Auto Transform er H.V Transform er	_
8	Observation Table,		
	Look-up Table, Output	Sl. Breakdown Breakdown strength of the No. voltage in kV oil in kV/ mm 1 Image: Strength of the	
		2	
			+
		6	
			+
			1
9	Sample Calculations		4
LO 11	Graphs, Outputs Results & Analysis	Breakdown strength of oil = (Breakdown voltage/ Distance betwee	n
<u> </u>		the two electrodes) in kV/ mm	
12	Application Areas		_
1 <u>3</u>	Remarks Faculty Signature		-
٤4	with Date		

COURSE PLAN - CAY 2019-20 Experiment 04 : Keywords and identifiers

-	Experiment No.:	3	Marks	3	Date Planned		Date Conducted	
1	Title	HIGH	VOLTAG	E AC FLA	SH OVER	CHARACTER	ISTICS OF	DIFFERENT
		ELECT	RODE CC	NFIGURATI	JN			
2	Course Outcomes							
3	Aim	LO OD Configu 1 2 3	atain the aration in HVAC Plane Point Plane	 flash over air subjected plane elect point elect point elect 	er characte d to trodes rodes trodes	eristics of th	ne following	g electrode
4	Material / Equipment Required	Contro	l panel, H	IV transform	er, Rod gap	apparatus, Di	scharge rods	5.
5	Theory, Formula Principle, Concept	,	<u> </u>		51			
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Conned 2. transfo unit 3. wheel 4 4. 5. 6. 7. 8. 9. 10. 11. 12. NOTE: electro 13. 14.	ctions are The co rmer and Require and Varia control p All the a Connec Switch (indicato Press th Now gra voltage simultar Press M Bring th The bu discharg The abo The bu discharg Nowy the all the p RODS. Plot the stress vo	e made as per ntrol panel l secondary d electrodes ac (dimmer) of panel is kept pparatus are t 230 Volts, A DN the main r will glow. e HT ON pus adually incre break down neously HT O IEMORY pus e variac to m shings of t ged by using ove procedur me proced plane - point e dimmer to parts of the break down erses sphere	er the circuit output is of the HV tr s gap distar of in minimum e grounded AC supply to supply, pre sh button, the asing the v n will takes N will glow h button to ninimum pos he transfor DISCHARG re is repeated lure is rep electrodes minimum p apparatus	diagram. connected ansformer is of nee is adjuste position firmly to the n the control p ss the MAINS ne HT ON india oltage by usir s place betw OFF. note down the sition and swit mer and ele E RODS ed for different beated for d iii) point - poir osition and sw are discharg	to the prin connected to ad with the h nother groun anel ON button, f cator will glo ng variac kno een the ele e break dow ch OFF main ectrodes of gap distance witch OFF the ed by using gap distance	nary of HV o the rod gap help of hand d. UNIT READY w. ob, at certain ctrodes and n voltage. supply. rod gap is e hbination of l. e supply and DISCHARGE and Electric

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Look-up 0 Fuse 8 Observation Table, Look-up 0 Transform er 8 Observation Table, Look-up 0 Transform er 9 No Electrodes distance in mm gap 9 Primary Input 9 PLANE TO PLANE Transform 1 5 mm Transion 2 10 mm Transion 3 15 mm Transion 3 1	Fuse Fuse Fuse A uto Transformer H.V H.V H.V H.V H.V H.V H.V H.V
Bagram. Heaction Fuse 60kV R od G ap Equation, Expected Fuse 60kV A.C. R od G ap 230V,50Hz A.C. Supply Auto Transformer H.V. 8 Observation Table. Transformer H.V. 0utput Table. Voltage Transform er 9 Diservation Table. Transform er 1 5 mm Transform Transform 2 10 mm Time Time 2 10 mm Time Time 2 10 mm Time Time 3 15 mm Time Time 2 10 mm Time Time 2 10 mm Time Time 3 15 mm Time Time 1 5 mm Time Time 2 10 mm Time Time 3 15 mm Time Time 2 10 mm Time Time 3 15 mm Time Time	Fuse Fuse Fuse Fuse GOKV A.C RodGap H.V Transformer H.V H.V H.V H.V H.V H.V H.V H.V
B Observation Table. Output Table. SI No Electrodes gap Primary Input Breakder Input SI No Electrodes gap Voltage Triansformer H. V Transformer H. V Transfore	Fuse 60 k V A uto R od G ap A uto H.V Transform er H.V JE TO PLANE H.V 10 mm H.V 10 mm H.V 20 mm H.V 20 mm H.V
8 Observation Table, Look-up Output 0 Image: Single Control of Contro of Control of Control of Control of Control of Control	Private and the second
8 Observation Table, Look-up Output SI No Electrodes gap Primary Input Voltage Primary Input Breakdor 1 5 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 5 mm 1 2 10 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 5 mm 1 3 15 mm 1 5 mm 1 2 10 mm 1 5 mm 1 3 15 mm 1 1 1 3 15 mm 1 1 1 1 3 15 mm	Puse A uto A uto Transformer H.V. H.V.
8 Observation Table, Look-up Output SI No Electrodes gap Primary Input Voltage Primary Input Primary Input Voltage Breakder Transformer 1 5 mm 1 5 mm 1 5 25 mm 1 2 10 mm 1 5 mm 1 5 25 mm 1 2 10 mm 1 5 mm 1 5 25 mm 1 1 5 mm 1 2 10 mm 1 5 mm 1 2 10 mm 1 5 mm 1 1 5 mm 1 2 10 mm 1 5 mm 1 5 1	Prise A uto Transformer H.V H.V H.V H.V H.V H.V H.V H.V
8 Observation Table, Look-up Rod G ap 0utput Table, Output Image: Si No Electrodes distance in mm gap PLANE TO PLANE Triansform er 1 5 mm Image: Si No Image: Si No 2 10 mm Image: Si No Si No Electrodes 9 Observation Table, Cotput Image: Si No Image: Si No 1 5 mm Image: Si No Image: Si No Image: Si No 1 5 mm Image: Si No Image: Si No Image: Si No 1 5 mm Image: Si No Image: Si No Image: Si No 1 5 mm Image: Si No Image: Si No Image: Si No 2 10 mm Image: Si No Image: Si No Image: Si No 3 15 mm Image: Si No Image: Si No Image: Si No 2 10 mm Image: Si No Image: Si No Image: Si No 3 15 mm Image: Si No Image: Si No Image: Si No 3 15 mm Image: Si No Image: Si No Image: Si No 3 15	A uto R od G ap A uto H.V. Transformer H.V. Transformer Transformer Breakdown voltage in KV Tri Tri Tri 5 mm Image 10 mm Image 15 mm Image 20 mm Image 20 mm Image TTO PLANE Image
8 Observation Table. 0utput Table. 0utput Sl No Electrodes gap Primary Input Breakder 0utput Transformer Image: Sl No Electrodes gap Primary Image: Sl No Electrodes	A uto A uto Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer Tr1 Tr2 H.V Tr1 Tr2 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr1 Tr2 Tr2 Tr2 Tr1 Tr2 Tr2 Tr2 Tr2 Tr2 Tr2 Tr2 Tr2
8 Observation Table. Output SI No Electrodes gap PLANE TO PLANE 1 5 mm 1 5 mm 2 2 10 mm 1 3 15 mm 1 4 20 mm 1 5 25 mm 1 1 5 mm 1 2 10 mm 1 3 15 mm 1 4 20 mm 1	A u to A u to Transform er H.V Transform er Tri Tri Tri Tri Tri Tri Tri Tr
A.C.Supply Auto Auto Transformer H.V Transformer B Observation Table. Output SI No Electrodes gap Primary Instruction Trainsformer H.V Transformer B Observation Table. Output SI No Electrodes gap Primary Instruction Instructin Instruct	A uto Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer Tr1 Tr2 HETO PLANE 5 mm 10 mm 15 mm 20 mm 25 mm
8 Observation Table, Look-up Table, Output SI No Electrodes gap Armany Voltage 9 PLANE TO PLANE 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm 9 POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 2 10 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm 2 10 mm 3 15 mm 2 20 mm 5 25 mm 2 10 mm 3 15 mm 2 20 mm 3 15 mm 4 20 mm 3 15 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	A uto Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer Transformer Transformer H.V Transformer Transformer Transformer Transformer H.V Transformer Transformer Transformer Transformer Transformer H.V Transformer Transformer Transformer H.V Transformer Transformer Transformer H.V Transformer H.V Transformer Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V H.V H.V H.V H.V H.V H.V H.V
A uto A uto Transformer H.V Transformer B Observation Table. Look-up Output Sl No Electrodes gap Primary Input Breakder Voltage Tri PLANE TO PLANE 1 5 25 mm POINT TO POINT 1 5 2 10 mm 3 15 mm 2 15 mm 25 mm	A uto Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Transformer H.V Tri Breakdown voltage in KV Tri Tri Tri H.V Tri Tri Tri Tri Tri Tri Tri Tri
A U0 Transformer A U0 Transformer H.V Transformer 8 Observation Table, Look-up Table, Output SI No Electrodes gap distance in mm PLANE TO PLANE 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 1 5 mm 2 10 mm 3 15 mm 2 20 mm 5 25 mm	A UTO Transformer H.V Transformer H.V Transformer Breakdown voltage in KV Voltage ITT1 Tr2 IE TO PLANE 5 mm 10 mm 15 mm 20 mm 25 mm
8 Observation Table, Look-up Table, Output 8 Diservation Table, Look-up Table, Output 9 Sl No Electrodes gap distance in mm Primary Input Voltage Breakder Triansion Breakder Triansi Triansion Breakder Triansion Breakder Tri	H.V Transformer H.V Transformer Electrodes gap distance in mm Primary Input Voltage In KV Voltage Infra Input Voltage In KV IT I Tr2 IE TO PLANE INFRA INFR
B Observation Table, Look-up Table, Output SI No Electrodes gap distance in mm Primary Input Voltage Breakder International Internation Internatinternatintereformed Internatinternational Internation	H.V Transformer Electrodes gap Primary Input Breakdown voltage in KV Voltage III Tr1 Tr2 JE TO PLANE III Tr1 Tr2 JE TO PLANE III III Tr2 JE TO PLANE IIII IIII Tr2 JE TO PLANE IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
8 Observation Table, Look-up Table, Output Sl No Electrodes gap distance in mm Primary Input Voltage Breakder Friedrichten friedriten friedrichten friedrichten friedrichten	Transformer Electrodes gap Primary Input Breakdown voltage in KV Voltage IE TO PLANE 5 mm 10 mm 15 mm 20 mm 25 mm
8 Observation Table, Look-up Table, Output SI No Electrodes gap distance in mm Primary Voltage Breakder Tri 1 5 mm Tri Tri 2 10 mm 1 5 mm 3 15 mm 1 5 mm 2 10 mm 1 5 mm 3 15 mm 1 5 mm 2 10 mm 1 5 mm 3 15 mm 1 5 mm 2 10 mm 1 5 mm 3 15 mm 1 5 mm 2 10 mm 1 5 mm 3 15 mm 1 5 mm 2 10 mm 1 5 mm 3 15 mm 1 5 mm 3 15 mm 1 1 mm 3 15 mm 1 1 mm 4 20 mm 1 1 mm 5 25 mm 1 1 6 25 mm 1 1 1	Electrodes gap Primary Input Breakdown voltage in KV distance in mm Voltage Input Input Input IE TO PLANE Input Input Input 5 mm Input Input Input 10 mm Input Inp
8 Observation Table, Look-up Table, Output SI No Electrodes gap distance in mm Primary Input Voltage Breakded to the second sec	Electrodes gap Primary Input Breakdown voltage in KV distance in mm Voltage Input Input Input IE TO PLANE Input Input Input 5 mm Input Input Input 10 mm Input Input Input 20 mm Input Input Input 25 mm Input Input Input
8 Observation Table, Look-up Output Table, Output SI No Electrodes gap distance in mm Primary Input Voltage Breakded for the second s	Electrodes gap Primary Input Breakdown voltage in KV distance in mm Voltage Input Input Input IE TO PLANE Input Input Input Input 5 mm Input Input Input Input 10 mm Input Input Input Input 10 mm Input Input Input 20 mm Input Input Input 25 mm Input Input Input
Look-up Table, Output SI No Electrodes gap Primary Input Breakded Indistance in mm Input Input Input Input Input Input PLANE TO PLANE Input Input Input Input Input Input Input Input Input Input Input Input Input Input Input <t< td=""><td>Electrodes gap Primary Input Breakdown voltage in KN distance in mm Primary Voltage Input Tr1 Tr2 IE TO PLANE TO PLANE 5 mm 10 10 10 10 10 10 10 10 10 10 10 10 10</td></t<>	Electrodes gap Primary Input Breakdown voltage in KN distance in mm Primary Voltage Input Tr1 Tr2 IE TO PLANE TO PLANE 5 mm 10 10 10 10 10 10 10 10 10 10 10 10 10
Output Sl No Electrodes distance in mm gap Primary Unput Voltage Breakded I 5 mm Image	Electrodes distance in mm gap distance Primary Voltage Input Voltage Breakdown voltage in KV IE TO PLANE Input Imput Imput Voltage Input Imput Imput Imput Voltage Input Imput I
SL No Electrodes distance in mm gap Primary Voltage Input Voltage Breakded 1 5 mm -	Electrodes gap Primary Input Breakdown voltage in KV distance in mm Voltage Input Input Input Ite TO PLANE Input Input Input 5 mm Input Input Input 10 mm Input Input Input 10 mm Input Input Input 20 mm Input Input Input 25 mm Input Input Input
distance in mm Voltage Tr1 PLANE TO PLANE 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	distance in mm Voltage Tr1 Tr2 IE TO PLANE Image 5 mm Image 10 mm Image 15 mm Image 20 mm Image 25 mm Image
PLANE TO PLANE	IE TO PLANE Tr1 Tr2 5 mm 0 0 10 mm 0 0 15 mm 0 0 20 mm 0 0 25 mm 0 0
PLANE TO PLANE Tr1 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm 0 25 mm 0 25 mm	Tr1 Tr2 IE TO PLANE Image: Constraint of the second secon
PLANE TO PLANE 1 5 mm 1 5 mm 2 2 10 mm 3 3 15 mm 4 4 20 mm 5 5 25 mm 7 POINT TO POINT 1 5 mm 2 10 mm 1 3 15 mm 1 2 10 mm 1 3 15 mm 1 4 20 mm 1 5 25 mm 1 6 25 mm 1 7 15 mm 1 10 mm 1 1	IE TO PLANE 5 mm 5 mm 10 mm 10 mm 15 mm 20 mm 10 mm 25 mm 10 mm
1 5 mm 1 2 10 mm 1 3 15 mm 1 4 20 mm 1 5 25 mm 1 POINT TO POINT 1 5 1 5 mm 1 2 10 mm 1 3 15 mm 1 2 10 mm 1 3 15 mm 1 4 20 mm 1 5 25 mm 1 0 15 mm 1 15 mm 1 10 mm 3 15 mm 1 4 20 mm 1 5 25 mm 1	5 mm 10 mm 10 mm 15 mm 20 mm 10 mm 25 mm 10 mm
2 10 mm 3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	10 mm 15 mm 15 mm 20 mm 25 mm 25 mm
3 15 mm 4 20 mm 5 25 mm POINT TO POINT 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	15 mm 20 mm 25 mm T TO POINT
4 20 mm 5 25 mm POINT TO POINT 1 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	20 mm 25 mm T TO POINT
5 25 mm POINT TO POINT 1 1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	
1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	
1 5 mm 2 10 mm 3 15 mm 4 20 mm 5 25 mm	
2 10 mm 3 15 mm 4 20 mm 5 25 mm	5 mm
3 15 mm 4 20 mm 5 25 mm	
5 25 mm	20 mm
	25 mm
	T TO PI ANF
1 5 mm	
2 10 mm	5 mm
3 15 mm	5 mm 10 mm
4 20 mm	5 mm 10 mm 10 mm 15 mm
5 25 mm	5 mm 10 mm 10 mm 15 mm 20 mm 10 mm
	5 mm 10 mm 10 mm 15 mm 20 mm 15 mm 25 mm 10 mm

9	Sample Calculations	Labora Labora Air der Transfc TABLE For diff	atory tem atory pres osity is ex ormer rat a AIR DEN erent val	iperature ssure F xpressed io=V ₂ /V ₁ ISITY CO ues of gi	t = P = 680 m as = (P* 2 RRECTIC ves differ	in °centi 1m of Hg 293)/(760 DN FACTC rent value	grade 9(273 + t)))R es of K			
			0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05
		K	0.72	0.76	0.81	0.86	0.90	0.95	1.00	1.05
11	Results & Analysis									
12	Application Areas									
13	Remarks									
14	Faculty Signature with Date									

Experiment 05 : HIGH VOLTAGE AC FLASH OVER CHARACTERISTICS OF DIFFERENT ELECTRODE CONFIGURATION

-	Experiment No.:	5 Marks		Date Planned		Date Conducted	
1	Title	HIGH VOLTAG	E AC FLAS	SH OVER (ION	CHARACTER	ISTICS OF	DIFFERENT
2	Course Outcomes						
3	Aim	To obtain the configuration i HVAC 4 Plane 5 Point 6 Plane	e flash ove n air subjec - plane ele - point elec e - point elec	r character ted to ctrodes trodes ctrodes	ristics of th	ne following	g electrode
4	Material / Equipment Required	1					
5	Theory, Formula, Principle, Concept						
6	Procedure, Program, Activity, Algorithm, Pseudo Code						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	230 V, 50 H z A.C.Supply	C on trol per el A uto Transform er	H.V Transform er	R od G ap		
8	Observation Table, Look-up Table,						

	COURSE PLAN - CAY	2019-20					BE-7-EE-	SKIT-Ph5k	01-F02-V2.2		
	Output		SI No)	Eleo	ctrodes ance in r	gar nm	o Prim Volta	ary Ir age	nput	Breakdown v
											Tr1
				NE TO PLA	NE						
			2		10	<u></u>					
			2		101	nm					
			4		201	nm					
			5		25 1	nm					
			POIN	ΙΤ ΤΟ ΡΟΙ	NT						
			1		5 m	m					
			2		10 1	nm					
			3		15 r	nm					
			4		20 ו	nm					
			5		25 ı	nm					
			POIN	IT TO PLA	NE						
					5 m	m					
			2		10 1	nm mm					
			1		201	nm					
			5		201	nm					
	Calculations	• Air der Transfc TABLE For diff	Labora atory pro- nsity [] is prmer ra : AIR D erent va 0.70 0.72	tory tempessure s express atio=V ₂ / V ENSITY alues of 0.75 0.76	Derature P = 680 ed as [] '1 CORREC gives d 0.80 0.81	t = 0 mm of = (P* 29 CTION F, ifferent v 0.85 0.86	in °ce Hg 3)/(760(2 ACTOR /alues of 0.90	entigrad 273 + t) K 0.95 0.95	le) 1.00 1.00	1.05	5
10	Graphs, Outputs										
11	Results & Analysis	Theore	etical br	eakdown	voltage	$V_{\rm T}=V_{\rm rm}$	₅*K*Tran	sformer	ratio=		
		Where in cm	K – Cor	rection fa	actor		S	- Sphe	re gap d	istanc	e
12	Application Areas		To chec	ck the bre	ak-dowr	n voltage	ofa				_
13	Remarks										_
14	with Date										

Experiment 06 :SOLID STATE NEGATIVE PHASE SEQUENCE RELAY

-	Experiment No.:	1	Marks		Date		Date	
					Planned		Conducted	
1	Title	SOL	LID STATE N	EGATIVE PH	ASE SEQUEN	NCE RELAY		
2	Course Outcomes							
3	Aim	Tos	study the op	eration of a r	legative phas	se sequence	relay	

	COURSE PLAN - CAY	2019-20		BE-7-EE-SKIT-Ph5b1-F02-\	/2.2	
4	Material / Equipment Required	Negative - se motor.	quence relay module, co	onnecting wires, Rheostat	, Induction	
5	Theory, Formula, Principle, Concept	,				
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Connections ar 1 2 3 4 5 6 7 8	 re made as shown in circui The auxiliary power clo Keeping the rheostat ir Push CB ON button. CE starts running. Note down the ammeted Adjust the rheostat to unbalance. Negative sequence relations. Push CB off/Reset. Without adjusting/dist CB ON and note the an Interchange the 3- RYE the readings. 	it diagram. Ised and 3-4 input is conne in cut in position switch ON 3 ON indicator will glow and er reading. In create the negative sec ay gets active and 'Trip' sig urbing the rheostat , swit inmeter readings and trip tir 3 sequence and observe an	cted. the mains. t the motor quence i.e. nals. ch ON the nings. nd tabulate	
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph					
8	Observation Table, Look-up Table, Output - -	• Normal condition Unbalanced conditional One Phase is open	Current in R-Ph (A)	Current in Y-Ph (A)	Current in (A)	n B-Ph
9 10 11 12 13 14	Sample Calculations Graphs, Outputs Results & Analysis Application Areas Remarks Faculty Signature with Date					

Experiment 02 : CHARACTERISTICS OF ELECTRO MECHANICAL UNDER VOLTAGE RELAY

-	Experiment No.:	1	Marks		Date		Date		
					Planned		Conducted		
1	Title	CH	ARACTERIS	TICS OF ELE	CTRO MECH	IANICAL UN	DER VOLTA	GE RELAY	
2	Course Outcomes	Ana	alyze electr	o mechanic	al under vo	ltage relay.			
3	Aim	То	To conduct test on electro mechanical under voltage relay.						
4	Material Equipment Required	/Un	der voltage	relay modu	le, Patch ch	ords.			

5	Theory, Formula	,				
6	Principie, Concept		1 Relay conne	actions are made a	s shown	in figure
U	Program,	2.	Set a required PSN	4 and TSM in the re	elay.	in ligure.
	Activity, Algorithm,	3.	Ensure time inte	erval meter swite	h is in	TIM position and
	1. Pseudo		Protection timer	switch in ON po	sition. S	2 switch is in ON
	Code	4	Keeping the dimm	ner in zero positior	n togale	switch in set mode
			switch on the main	ns.	i, toggie	Switch in Sec mode
		5.	Adjust the voltag	e level above t	he thres	hold level if under
		6	voltage relay using	g dimmer 1.	ust than	nder veltere level
		0.	using dimmer 2 (I	ess than the set vo	nltage)	inder voltage lever
		7.	Push TEST STOP/R	ESET button. Do n	ot distur	b the dimmer 1 and
		8.	Once the disc sto	ps rotating bring t	togale sv	vitch to TEST mode
			and push TEST ST	ART button.		
		9.	Under voltage t	rip occurs and tri	ip indicat	tor will glow. Note
			down time interv	val meter and vo	oltmeter	reading after the
		10.	Press RESET but	y. ton and repeat t	the oper	ation by adjusting
			different voltage a	and TMS setting.		
		11.	Draw the graph be	etween trip time v/	's % closi	ng voltages.
7	Plack Circuit	12.				
/	Model Diagram	,				
	Reaction Equation	,				
	Expected Graph					
8	Observation Table	Plug se	etting=			
	Output	Pick up	voltage=			
		Drop o	ff voltage=			
		C - ++!				C attin a
		voltad	g voltage $v_s =$	VOILS		Setting
	-	SI No	Applied voltage	Operating time	SI No	Applied voltage
	_		in Volts > V₅	in sec		in Volts > V₅
	-	1			1	
	-	2			2	
	-	4			4	
	-	5			5	
	-	6			6	
	_	7			7	
9	Sample					
	Calculations					
10	Graphs, Outputs					
11	Results & Analysis					
12	Auguliantian Angel	-				
Later Street	Application Areas					1
13	Remarks					
13 14	Application Areas Remarks Faculty Signature	5				

Experiment 07 : MICROPROCESSOR BASED UNDER VOLTAGE RELAY

1TitleMICROPROCESSOR BASED UNDER VOLTAGE RELAY2Course OutcomesDraw the operating characteristics of microprocessor b voltage relay3AimTo draw the operating characteristics of microprocessor b voltage relay4Material Equipment Required/Microprocessor based under voltage relay model, Patch cho5Theory, Formula, Principle, Concept $V_s = [1 - [0.05 - a]]V_n$ Where V_s - set level voltage V_n - 110 Volts a - weight of switch in ON position $V_s = [1 - [0.05 - a]]V_n$ 6Procedure, Program, Activity, Algorithm,1. Ensure both the dimmers in OFF position. 2. Connections are made for the relay and injection uni 3. Set the over/under voltage by opening the glass	e nted					
2Course OutcomesDraw the operating characteristics of microprocessor b voltage relay3AimTo draw the operating characteristics of microprocessor b voltage relay4Material Equipment 						
3 Aim To draw the operating characteristics of microprocessor to voltage relay 4 Material /Microprocessor based under voltage relay model, Patch cho Equipment Required 5 Theory, Formula, Principle, Concept V _s = [1 - [0.05 - a]]V _n 6 Procedure, Program, Activity, Algorithm, Set the over/under voltage to voltage the over/under voltage by opening the glass	r based under					
 4 Material Equipment Required 5 Theory, Formula, Principle, Concept 6 Procedure, Program, Activity, Algorithm. Microprocessor based under voltage relay model, Patch cho V_s = [1 - [0.05 - a]]V_n Where V_s - set level voltage V_n- 110 Volts a - weight of switch in ON position V_s = [1 - [0.05 - a]]V_n - for under voltage T=K(0.1+∑t)= 1. Ensure both the dimmers in OFF position. 2. Connections are made for the relay and injection uni 3. Set the over/under voltage by opening the glass 	or based under					
5Theory, Formula, Principle, Concept $V_s = [1 - [0.05 - a]]V_n$ Where V_s - set level voltage V_n - 110 Volts $a - weight of switch in ON positionV_s = [1 - [0.05 - a]]V_n - for under voltageT = K(0.1 + \Sigma t) =6Procedure,Program,Activity, Algorithm,1. Ensure both the dimmers in OFF position.2. Connections are made for the relay and injection uni3. Set the over/under voltage by opening the glass$	chords.					
 6 Procedure, Program, Activity, Algorithm, 1. Ensure both the dimmers in OFF position. 2. Connections are made for the relay and injection unit 3. Set the over/under voltage by opening the glass 	$V_{s} = [1 - [0.05 - a]]V_{n}$ Where V _s - set level voltage V _n - 110 Volts a - weight of switch in ON position V_{s} = [1 - [0.05 - a]]V_{n} - for under voltage T=K(0.1+ Σ t)=					
Pseudo CodeSW2 block switches set normal inverse or definite i as required.4. Ensure the time interval meter position in TI protection timer switch in ON position bring both the zero position.5. Set the time multiplier setting.6. Switch on the main, push TEST START button CB get the dimmer voltage to set approximate injection volt7. Push test Stop/Reset button.8. Without disturbing dimmer 1 and dimmer 2 bring switch to test mode and push test to start button.9. Note down the voltage at which under voltage relations10. Repeat the operation by adjusting different voltage setting.11. Draw the graph of trip time V/S Multiple of set voltage	unit. ss plate. Using ite inverse time TIM position, the dimmer to gets on. Adjust voltage. ring the toggle relay trips and pltage and TMS ltage.					
7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph						
8 Observation Table, Look-up Table, Output 9 SI.No Fault Voltage Multiple of set voltage=Fault voltage=Fault voltage=*100 Set PSM Operating Time 1 1 Set PSM Image: TMS= 2 1 Image: TMS= Image: TMS= 3 1 Image: TMS= Image: TMS=	e 5=					

	COURSE PLAN - CAY	BE-7-EE-SKIT-Ph5b1-F02-V2.2	
		4	
		5	
	_	6	
	-	7	
	-		
a	Sample		
9	Calculations		
10	Graphs, Outputs		
11	Results & Analysis		
		Conducted test on electo mechanical un	der voltage relay
12	Application Areas	To protect electrical device agains	st under voltage fault
13	Remarks		
14	Faculty Signature with Date		

Experiment 08 :HIGH VOLTAGE DC FLASH OVER CHARACTERISTICS OF DIFFERENT ELECTRODE CONFIGURATION

-	Experiment No.:	1	Marks		Da Plan	te ned		Date Conduc	ted		
1	Title	HIGI ELE(IIGH VOLTAGE DC FLASH OVER CHARACTERISTICS OF DIFFERENT								
2	Course Outcomes										
3	Aim	To conf Plan Poin Plan	o obtain the flash over characteristics of the following electrode onfiguration in air subjected to HVDC lane - plane electrodes. oint - point electrodes. lane - point electrodes.								
4	Material / Equipment Required	Con ⁻ Rod	ontrol panel, HV transformer, Rectifier, RC-Filter, Bleeding resistor. od gap apparatus, Discharge rods,								
5	Theory, Formula, Principle, Concept	Labo Lab Air Trar	Laboratory temperature t = in °centigrade Laboratory pressure $P = 680 \text{ mm of Hg}$ Air density is expressed as = $(P*293)/(760(273 + t))$ Transformer ratio=V ₂ /V ₁ For different values of gives different values of K								
			0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	
6	Procoduro				<u>v.or</u>	0.00		i.agram	1.00	1.05	
0	Procedure, Program, Activity, Algorithm, Pseudo Code		2. All the a to the n 3. The req	apparatus nother gro uired rod	and cor und. gap dis	tance is	nel should	d be prop with th	perly gro	ounded of hand	

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		 wheel Now connect 1-phase, 230 Volt AC supply to the control panel Switch ON the main supply Bring the variac (Auto transformer) to zero position; as a result UNIT READY indicator will glow. Press the HT ON button, then gradually increase the voltage until the breakdown occurs (SAMPLE FAILED indicator will glow) NOTE: In case HVDC sphere gap when we applying voltage observing the DC voltmeter. 10. 11. When breakdown occurs note down the voltage. 12. Once again bring the variac to minimum position, press RESET button, then SAMPLE FAIL indicator will OFF, and then switch off the supply. 13. Using discharge rods discharges all the apparatus. 14. The above procedures are repeated for the different values of rod gap distance NOTE: The same procedure is repeated for different combination of electrodes, [ii) plane - point electrodes iii) point - point electrodes]. 15. Vary the dimmer to minimum position and switch OFF the supply and all the parts of the apparatus are discharged by using DISCHARGE RODS. 16. Plot the break down voltage verses sphere gap distance. 	
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control panel Control Puse Control Control Puse Control Puse Control Control Puse Control Puse Control Puse Control Control Control Puse Control C	
8	Observation Table, Look-up Table, Output	SI No Electrodes gap Primary Input Breakdown voltage in I Si No Electrodes gap Voltage Input Breakdown voltage in I S mm Input Tr1 Tr2 PLANE TO PLANE Input Input Input Input 1 5 mm Input Input Input 2 10 mm Input Input Input 3 15 mm Input Input Input 4 20 mm Input Input Input 2 10 mm Input Input Input 2 10 mm Input Input Input 3 15 mm Input Input Input 3 15 mm Input Input Input 4 20 mm Input Input Input 5 25 mm Input Input Input	ı k

			5 mm			
		2	10 mm			
		3	15 mm			
		4	20 mm			
		5	25 mm			
9	Sample	Laboratory temp	erature t =	in °centigrae	de	 _
	Calculations	Laboratory press Air density is ex Transformer ratio rr	sure $P = 680$ pressed as $= (P = V_2/V_1)$	mm of Hg * 293)/(760(27	3 + t))	
10	Graphs, Outputs					
11	Results & Analysis					
12	Application Areas					
13	Remarks					
14	Faculty Signature with Date					

Experiment 09 : SIMULATION STUDY OF DIGITAL MOTOR PROTECTION

-	Experiment No.:	9	Marks		Date		Date				
	T:+! ~						Conducted				
1	litte	SIM	ULATION S		ITAL MOTOR	PROTECTION	N				
2	Course Outcomes	Ana	alyze the motor protection under different types of faults.								
3	Aim	Tos	study the mo	otor protectio	n principle by	y simulating	different typ	es of faults.			
4	Material / Equipment Required	Mot	or protectio	n study unit.							
5	Theory, Formula, Principle, Concept										
6	Procedure, Program,		1.	Connect the	three phase s	supply with	neutral and g	ground.			
	Activity, Algorithm, Pseudo Code		2.	Connect the mimic).	motor(termir	nals provide	ed at the top	side of the			
			3.	Switch on the	e supply of so	ource.					
			4.	Switch ob th indication (R)	e MCB on th (B)	ne testing ki	t and look fo	or power on			
			5.	Trip indicatio	n and buzzer	will be on re	eset it.				
			6.	Set the moto	r protection r	elay parame	eter .				
			i)	Inverse/	Definite char	acteristic-de	efinite.				
			íí)	Definite t	ime -2sec.						
			iii)	Reverse	ohase protec	tion-ON.					
			iv)	Under cu	rrent protect	ion –OFF.					
			v)	Ground fa	ault-0.05sec.						
			vi)	Stall func	tion-ON.						
			vii)	Lock fund	ction –ON-20	0%.					
			viii	CT ratio -	1						
			ix)	Phase fai	l –ON.						
			x)	Store.							
		Adj	ust the dimn	ner to 415V.							
		Pus	h motor Ol	V button, en	suring that t	here is no	load on the	e motor and			
		obs	erve the cur	rent and volt	age of all the	phases and	record it.				
7	Block, Circuit, Model										
	Diagram, Reaction										

COURSE PLAN - CAY 2019-20 Equation, Expected Graph 8 Observation Table, Table, Look-up Output Sample Calculations 9 10 Graphs, Outputs 11 Results & Analysis 12 Application Areas 13 Remarks Faculty Signature 14 with Date

Experiment 10 : FIELD MAPPING USING ELECTROLYTIC TANK FOR i) PARALLEL PLATE CAPACITOR MODEL

-	Experiment No.:	10	Marks		Date		Date				
1	T :+1 -				Planned		Conducted				
T	litie	i) PAR	PARALLEL PLATE CAPACITOR MODEL								
2	Course Outcomes										
3	Aim	To p capac a fun mode config	lot the itance ction o l and juratior	e equipot and energ f distance b) co-ax 15.	ential fiel y and to p for a giv ial cable	ld lines a lot capacitive a) para capacito	and calcu tance and allel plate r model	lates the energy as capacitor electrode			
4	Material / Equipment Required	Auto Isolatio drawir	Transfor on trans ig sheet	mer, electi former, 10 v s, pencil and	rolytic tank Volts digital d eraser.	with pan A.C voltme	tograph ar ter or multi	rangement, meter, two			
5	Theory, Formula, Principle, Concept	Stress is give Capac a = h = ee	Stress can be found by considering any cell between the parallel plates s given by E = dv/dx = 2/b in Volts/cm Capacitance as a function of distance $C_1 = {}_{0r}(h/a)$ a = b/l; $l = length$ of the flux line; $b = width$ of the each cell h = height of the parallel plates								
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. 2. 3. 4. 5. 6. 7. 8.	Parallel The parallel The parallel Clean with the tips Now dritank. Connec multim Switch Keep the applyin with the First tre equiport Volts an	plate mode arallel plat ytic tank. water is pou of the para awing shee tions are r eter knob in ON main su pantogra g a small v e help of mu ace both t ential lines nd 8 Volts re	el le capacito ured (addeo illel plates. t is fixed or made as po the AC mo pply. ph needle o oltage of 1 ultimeter. the plates correspond espectively.	or model d) into the n the glass p er the circu de. on any one 0 Volts by p by using p ing to volta	is placed electrolytic blate of the uit diagram of the elect using auto bantograph ge of 2 Volt	inside the tank up to electrolytic and keep rodes, then transformer then trace s, 4 Volts, 6			
7	Block, Circuit, Model Diagram,										

	COURSE PLAN - CAY	2019-20	BE-7-EE-SKIT-Ph5b1-F02-V2.2
	Reaction Equation, Expected Graph	230V,50Hz A.C.Supply Auto Transformer	Isolating ElectronicTank
8	Observation Table, Look-up Table, Output		
9	Sample Calculations		
10	Graphs, Outputs		
11	Results & Analysis	Total capacitance of plate	C =F
12	Application Areas	To find capacitance	of any cable
13	Remarks	· · · · · ·	
14	Faculty Signature with Date		

Experiment 11 : MEASUREMENT OF HVAC AND HVDC BY USING SPHERE GAP MODEL

-	Experiment No.:	11	Marks		Date Planned		Date Conducted	
1	Title	MEA	SUREMENT	OF HVAC A	ND HVDC BY	Y USING SPH	IERE GAP MO	DDEL
2	Course Outcomes							
3	Aim	: 1 com) Measurei paring obta	nent of HV ined values	AC and HY with the ST	VDC using P values.	sphere gap	model and
4	Material / Equipment Required	Con Wat	ontrol panel, HV transformer, Sphere gap apparatus, Rectifier, Capacitor, /ater resister, Bleeding resistor, Thermometer, Discharge rod.					
5	Theory, Formula, Principle, Concept							
6	Procedure, Program, Activity, Algorithm, Pseudo Code		 Connect All the a the motility 3. 4. 4. 4. 5. 5. 5. 5. 	ions are mad apparatus an ner ground. The required neel The laborato nd calculate to Now connec DN the main s	de as per the Id control pa I sphere gap pry tempera the correction t 1-phase, 23 supply	circuit diagr nel should l distance is a ture and pr n factor o Volt AC su	am be properly g adjusted with ressure shou pply to the ca	grounded to In the help of uld be note ontrol panel

		 7. Bring the dimmer (Auto transformer) to zero position, as a result UNIT READY indicator will glow. 8. Press the HT ON button, then gradually increase the voltage until the breakdown occurs (SAMPLE FAILED indicator will glow) 9. Press MEMORY push button to note down the breakdown AC voltage. 10. Once again bring the variac to minimum position, press RESET button, then SAMPLE FAIL indicator will OFF, and then switch off the supply. 11. Using discharge rods discharges all the apparatus. 12. The above procedures are repeated for the different values of spear gap distance. 13. Plot the break down voltage verses sphere gap distance and Electric stress verses sphere gap distance.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	Control papel Vater Resistor SphereGap A.C. Supply Auto Transformer
8	Observation Table, Look-up Table, Output	SLNo Sphere gap Practical break down Theoretical

			distance in mm	voltage V _{P(RMS)} in KV	breakdown voltage
					V⊤∕√2 in KV (rms)
		1	10 mm		
		2	15 mm		
		3	20 mm		
		4	25 mm		
		5			
9	Sample Calculations				
10	Graphs, Outputs				
11	Results & Analysis				
12	Application Areas				
13	Remarks				
14	Faculty Signature				

Experiment 12 : FUSE CHARACTERISITICS

-	Experiment No.:	12	Marks		Date Planned		Date			
1	Title	FUSE	CHARAC	TERISITICS	i tannea		conducted			
2	Course Outcomes	To do	tormino	the charac	toristic of a	aiyon fuc	o wire by	i) Constant		
2	AIII	length and fu	and also determine the fuse constants and fusing factor							
4	Material / Equipment Required	1) Fus 2) An 3) Ind 4) SPS 5) Sto 6) Fus	e wire nmeter ((uctive lo T Switch p watch e board) – 20A) AC ad 1						
5	Theory, Formula, Principle, Concept									
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. 2. 3. 4. 5. 6. 7. 8. 9.	Connec Given fr The SPS By gra shows of The SPS operate The tim wire do varying The ab current Similarl current Plot the	ctions are m use wire is f 5T in closed dually vary current grea 5T switch is ed. ne taken for besn't blow the inducti ove proced s. y repeat t ratings of f graphs.	nade as show fixed on the position, the ing the inc ater than the opened and the blowou y-out slight ve load. ure are rep he above p use wire and	wn in figure fuse board e supply sw ductive load current ra d simultane it of the fus y increase eated for d procedure f d also for di	for given lovitch is closed d such that ting of the f ously the st the load lifferent val for different fferent leng	ength). ed. t Ammeter use wire. op watch is oted. If fuse current by ues of load t values of ths .		
7	Block,Circuit , Model Diagram, Reaction Equation, Expected Graph									

8	Observation Table, Look-up Table, Output						
			Length	L = 6cms	Length L = 12cms		
		Sl No	Load current in	Melting time in	Load current in	Melting time	in
			Amps	sec	Amps	sec	
		1					
		2					
		3					
		4					
		5					
9	Sample Calculations						
10	Graphs, Outputs						
11	Results & Analysis						1
12	Application Areas	Used in domestic application to protect electrical Devices					
13	Remarks						
14	Faculty Signature with Date						