TESTING OF POWER TRANSFORMERS

AS PER BUREAU OF INDIAN STANDARD IS-2026

HIGH VOLTAGE LABORATORY
ELECTRICAL ENGG. DEPARTMENT

GYAN GANGA INSTITITUTE OF TECHNOLOGY , JABALPUR

Prof. S. K. Bajpai

TESTING OF TRANSFORMERS

TESTING IS CARRIED OUT AS PER IS-2026.

- ROUTINE TESTS
- TYPE TESTS &
- SPECIAL TESTS

TESTING OF TRANSFORMER

ROUTINE TESTS (TO BE CARRIED OUT ON EACH JOB)

- 1.Measurement of winding resistance
- 2.Measurement of insulation resistance
- 3.Seperate source voltage withstand test (High Voltage tests on HV & LV)
- 4.Induced Over voltage Withstand test (DVDF test)
- 5.Measurement of voltage ratio
- 6.Measurement of NO LOAD LOSS & current.
- 7.Measurement of LOAD LOSS & IMPEDENCE.(EFFICIENCY & REGULATION)
- 8.Vector Group Verification
- 9.Oil BDV test.

TYPE TESTS

THESE TESTS ARE CARRIED OUT ONLY ON ONE TRANSFORMER OF THE LOT.

- All routine tests
- Additionally following tests are included in type tests

1. Lightening Impulse test.
2. Temperature rise test

SPECIAL TESTS

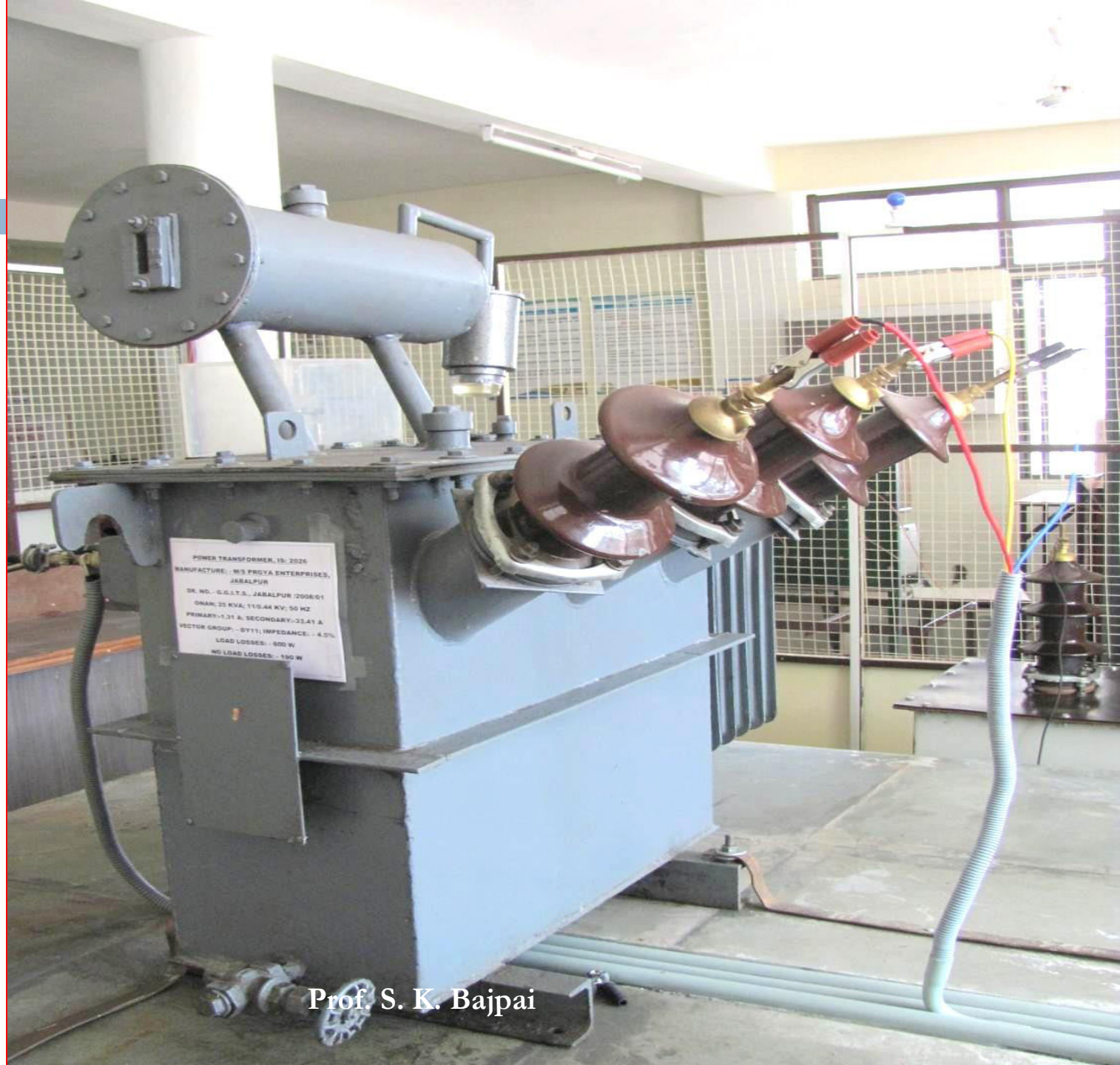
- Additional Impulse test
- Short circuit test
- Measurement of zero Phase sequence Impedance test.
- Measurement of acoustic noise level.
- Measurement of harmonics of the no load current.
- Magnetic balance test.

FOR CARRYING TEST AS PER THE IS -2026

FOLLOWING EQUIPMENT ARE NEEDED:-

1. Ammeters , Voltmeters , Wattmeters , Auto Transformer, Freq. meter.
2. 28 KV separate voltage source with standard test equipment.
3. Voltmeter to measure high voltage.
4. Double voltage double frequency test setup.
5. Oil break down voltage test setup.
6. Voltage booster for load losses and % impedance measurement.
7. Winding resistance measurement meter.
8. Turn ratio meter.
9. Insulation resistance tester.

TRANSFORMER UNDER TEST IN LAB



3 PHASE , 25KVA ,11/0.44 KV POWER TRANSFORMER

TRANSFORMER UNDER TEST IN LAB

Prof. S.K.Bajpai, HOD-EE & EX Deptt.

28 KV SEPARATE VOLTAGE SOURCE WITH STANDARD TEST EQUIPMENTS

VOLTMETER TO MEASURE HIGH VOLTAGE

Table (b):Breakdown voltages of spark gaps in KV_{max} at 20°C and 760 mm of Hg for alternating voltages, direct voltage of both polarities. One sphere is grounded.

Gap between spheres(cm)	Sphere diameter(cm)										
	2	5	6.25	10	12.5	15	25	50	75	100	150
0.05	2.8										
0.10	4.7										
0.15	3.4										
0.20	8.0	8.0									
0.25	9.6	9.6									
0.30	11.2	11.2									
0.40	14.4	14.3	14.2								
0.50	17.4	17.4	17.2	16.8	16.8	16.8					
0.60	20.4	20.4	20.2	19.9	19.9	19.9					
0.70	23.2	23.4	23.2	23.0	23.0	23.0					
0.80	25.8	26.3	26.2	26.0	26.0	26.0					
0.90	28.3	29.2	29.1	28.9	28.9	28.9					
1.0	30.7	32.0	31.9	31.7	31.7	31.7					
1.2	35.1	37.6	37.5	37.4	37.4	37.4	37.4				
1.4	38.5	42.9	42.9	42.9	42.9	42.9	42.9				
1.5	40.0	45.5	45.5	45.5	45.5	45.5	45.5				
1.6		48.1	48.1	48.1	48.1	48.1	48.1				
1.8		53.0	53.5	53.5	53.5	53.5	53.5				
2.0		57.5	58.5	59.0	59.0	59.0	59.0	59.0	59.0		
2.2		61.5	63.0	64.5	64.5	64.5	64.5	64.5	64.5		
2.4		65.5	67.5	70.0	70.0	70.0	70.0	70.0	70.0		
2.6		69.0	72.0	74.5	75.0	75.0	75.5	75.5	75.5		
2.8		72.5	76.0	79.5	80.0	80.0	81.0	81.0	81.0		
3.0		75.5	79.5	84.0	85.0	85.0	86.0	86.0	86.0	86.0	
3.5		82.5	87.5	95.0	97.0	98.0	99.0	99.0	99.0	99.0	
4.0		88.5	95.0	105	108	110	112	112	112	112	
4.5			101	115	119	122	125	125	125	125	
5.0			107	123	129	133	137	138	138	138	138
5.5				131	138	143	149	151	151	151	151
6.0				138	146	152	161	164	164	164	164
6.5				144	154	161	173	177	177	177	177
7.0				150	161	169	184	189	190	190	190
7.5				155	168	177	195	202	203	203	203
8.0					174	185	206	214	215	215	215
9.0					185	198	226	239	240	241	241

Correction Coefficient (δ and K)

(1) Relative air density (δ) at any other atmospheric conditions will be equal to;

$$\delta = \frac{T_0}{P_0}\frac{P}{T} = \frac{(20°C+273)}{760}\frac{P}{T} = 0.386\frac{P}{T}$$

Where; P_0 = Atmospheric pressure at standard condition (mm of Hg)

P = Pressure at test condition (mm of Hg)

T_0 = Temperature at standard condition (20°C +273)

T = Temperature at test condition (t°C + 273)

(2) Humidity factor (K) calculation;

$$K = 1 + (0.002(\frac{h}{\delta} - 8.5))$$

Where; h = Absolute humidity

δ = air density factor

Table (a): Correction Coefficient for relative air density

δ	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15
K	0.72	0.77	0.82	0.86	0.91	0.95	1.00	1.05	1.10	1.15

Formula for Breakdown voltage

(a) Modified Breakdown Voltage of air at actual conditions is equal to

$$V = V_o \, \delta \, K$$

Where; V_o = Breakdown voltage of air at normal atmospheric conditions

K=Humidity correction factor

δ =Air density factor

(b) Theoretical formula for calculation of breakdown voltage of air

$$V = \frac{27.2 \times \delta \times r \left[1 + \frac{0.54}{\sqrt{\delta \times r}}\right] \frac{d}{r}}{0.25\left[\frac{d}{r} + 1 + \sqrt{\left(\frac{d}{r} + 1\right)^2 + 8}\right]}$$

Where; δ=Relative air density factor

r=Radius of sphere in cm

d=Spacing between sphere in cm

Calculations for Breakdown voltage (28kv)

Diameter of the sphere D = 5 cm

Breakdown Voltage of air V = 28 kv

Measured Pressure at test condition P = 759.5 mm of Hg

Measured Temperature at test condition t = 21.4°C

Relative air density $\delta = \frac{T_o}{P_o}\frac{P}{T} = \frac{(20°C+273)}{760}\frac{P}{(t°C+273)}$

$$\delta = 0.386\frac{759.5}{(21.4°C+273)} = 0.995$$

Measured Relative humidity = 52 %

% Relative humidity = $\frac{Actual\ vapor\ density\ in\ {}^{gm}/_{m3}}{Saturated\ vapor\ density\ in\ {}^{gm}/_{m3}} \times 100$

Saturated vapor density = $(5.018+0.32321t+8.1847\times 10^{-3}t^2 + 3.1243\times 10^{-4}t^3)$

Where t =Temperature in °C=21.4°C

Saturated vapor density = 18.74 ${}^{gm}/_{m3}$

Actual vapor density (h) =0.52× 18.74 = 9.74 ${}^{gm}/_{m3}$

Humidity factor $K=1+(0.002(\frac{h}{\delta}-8.5)) = 1.002$

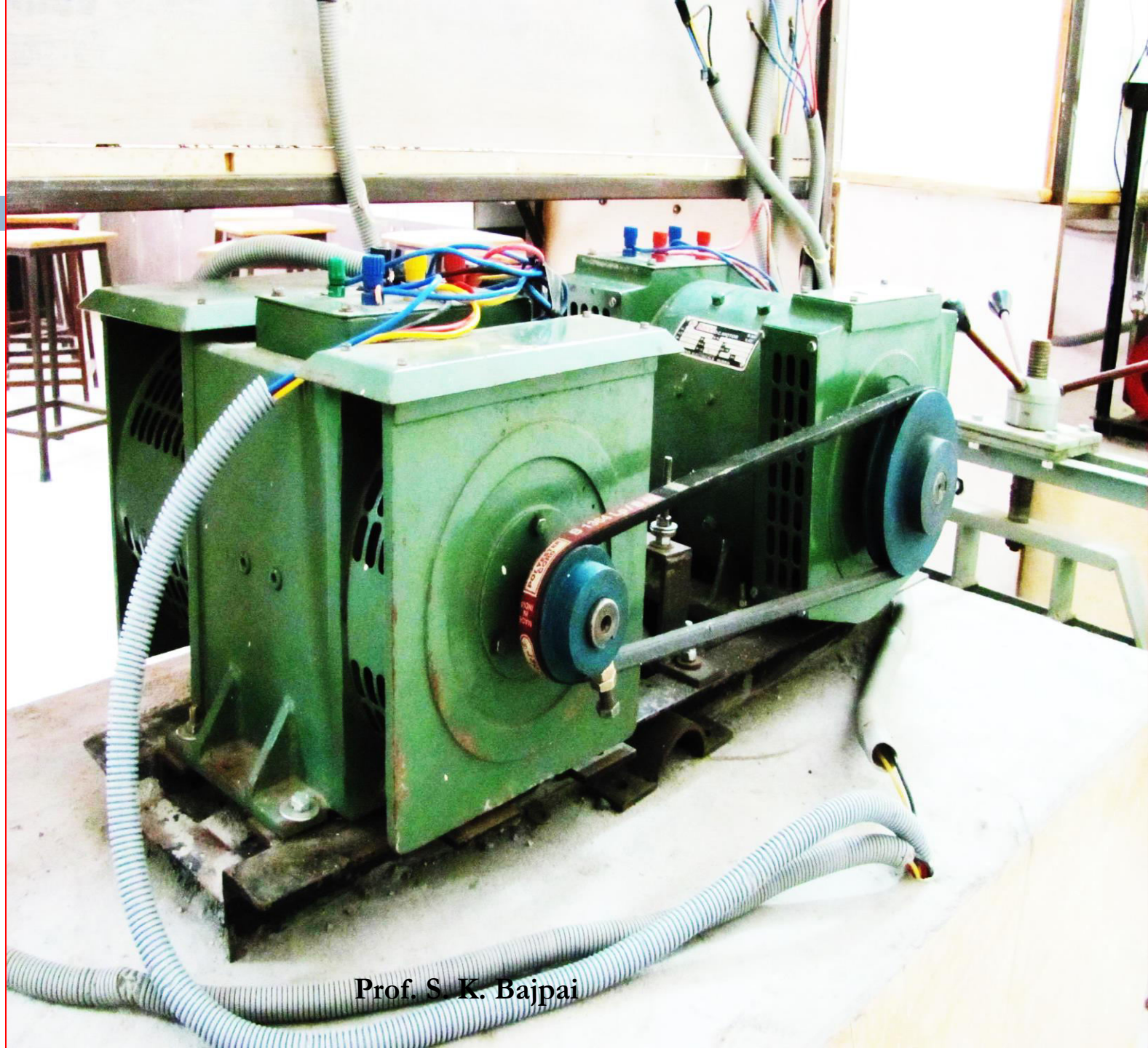
$$V = V_o\ \delta\ K$$

$$28 = V_o \times\ 0.995 \times 1.002$$

$$V_o = 28.07\ KV$$

Spacing between sphere d =0.85 cm

DOUBLE VOLTAGE DOUBLE FREQUENCY TEST SETUP



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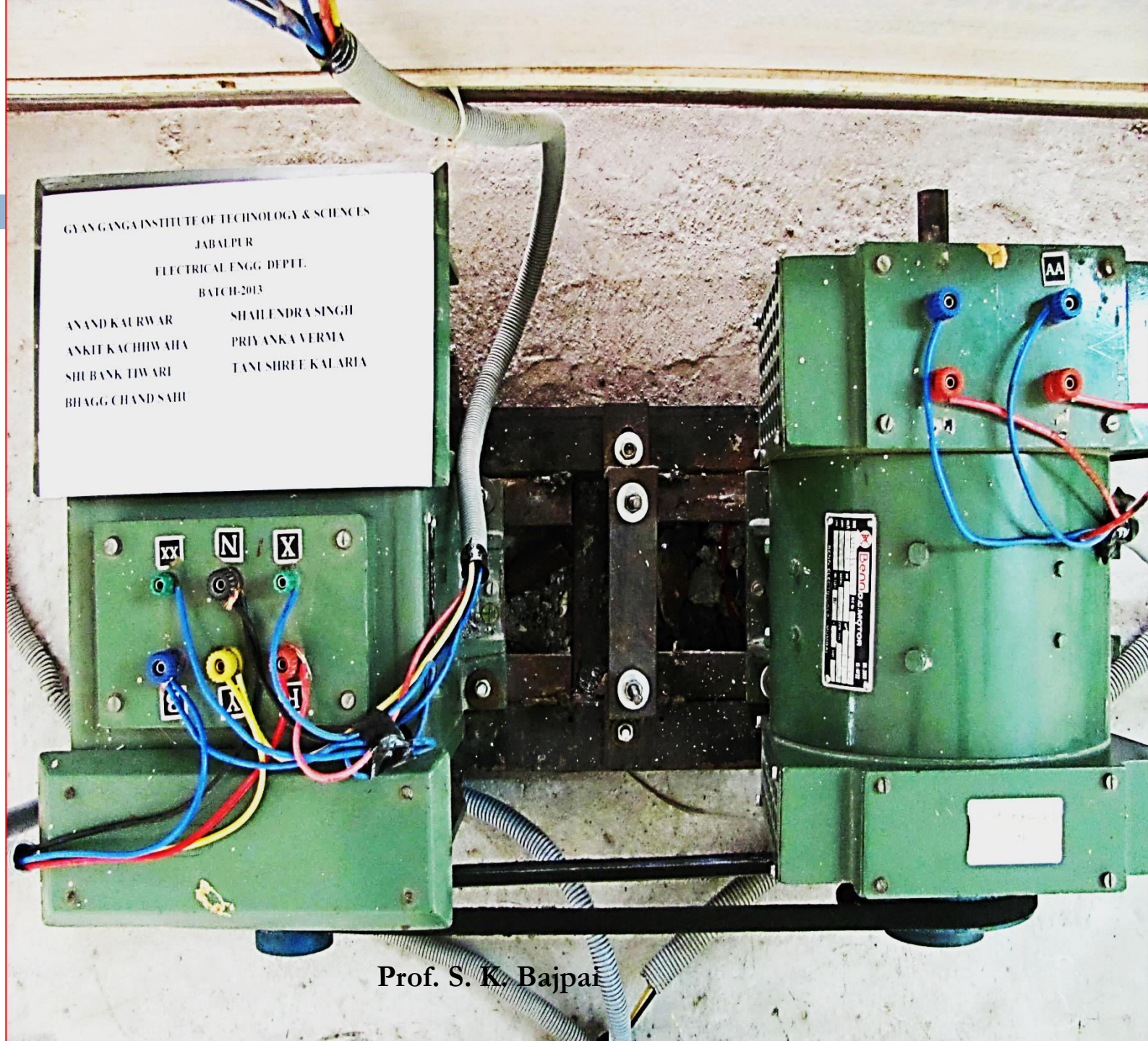

TRANSFORMER OIL BREAK DOWN VOLTAGE TEST SETUP

VOLTAGE BOOSTER FOR LOAD LOSSES AND % IMPEDANCE MEASUREMENT.

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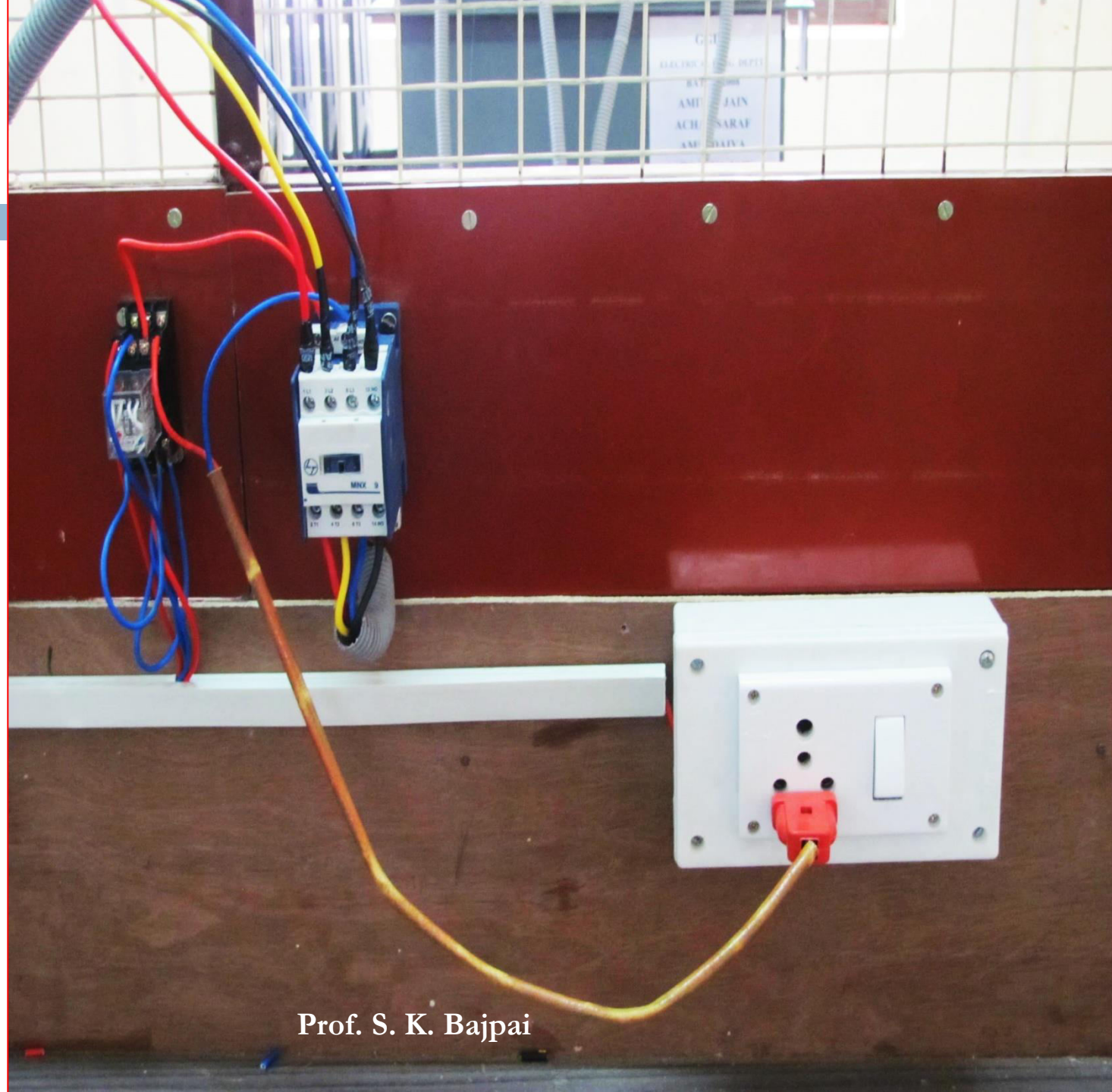
TIMER & RELAY BASED CONTROL CIRCUIT FOR THE DIFFERENT SETUPS TO CONDUCT THE SUITABLE HIGH VOLTAGE TESTING ON TRANSFORMERS



PROTECTION SETUP FOR ANY HARZADS DURING THE HIGH VOLTAGE TESTING

TEAM MEMBERS OF E.E. DEPTT. , G.G.I.T.S.,JBP.

Sr. No.	Name of Team Tembers	Designation
1.	Mrs. Shalini Vaishya	Assistant Prof. –E.E. Deptt.
2.	Mr. Rajeev Chauhan	Assistant Prof. –E.E. Deptt.
3.	Mr. Shirish Kumar Jain	Assistant Prof. –E.E. Deptt.
4.	Ms. Jasmeen Kaur	Assistant Prof. –E.E. Deptt.
5.	Mr. Kamal Yadav	Technical Assistant –E.E. Deptt.
6.	Mr. S.N . Sharma	Technical Assistant –E.E. Deptt.
7.	Mr. O.P. Navik	Technical Assistant –E.E. Deptt.
8.	Mr. L. C. Jain	Technical Assistant –E.C. Deptt.