Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Fourth Year Bachelor of Engineering (Electrical Branch)

With effect from: Academic Year 2020-21

Subject Code: EE801-N	Subject Title: **Commissioning and testing of Electrical Equipment**

Course Objective:

- To delineate terms Commissioning, Testing and Maintenance.
- To understand various types of essential test carried out while commissioning of various electrical equipments.
- To identify faults of Electrical Equipments and their remedies/ troubleshooting for the same.

A. Teaching / Examination Scheme

Teaching scheme				Total Credit	Evaluation Scheme					Total Marks
					Theory		IE Marks	CIA Marks	Pract. Marks	
L	T	P	Total							
Hrs	Hrs	Hrs	Hrs		Hrs	Marks				
3	0	2	5	4	3	70	30	20	30	150

1. **Transformer:** Testing procedure for HV testing, Phase shifting/ phase group, Radio interference, Ratio Test, Load loss, Separate source voltage testing, Induced voltage testing, Impulse & Surge testing, Noise level & vibration testing, Short circuit withstand test, Tan Delta test, Core insulation voltage test, Measurement of impedance, Testing of auxiliaries & safety device, Oil testing, Classification of Testing methods, Testing of bushing. DC & AC Resistance measurement, Temp. Rise test, Short circuit test, Dielectric test, Partial discharge, Insulation resistance testing, Polarity testing, Short time current rating, Impulse & surge testing, Determination of error & accuracy class, Power frequency voltage withstand test, over voltage inter-turn test. Determination of polarization index for transformer. Drying out procedure for transformer. Commissioning steps for transformer, Purification & Filtration Procedure for Transformer oil. Troubleshooting & Maintenance of transformer
2. **Induction Motor: Testing (3-phase & 1-phase):** Hammer test, testing against variation of voltage/current/frequency, Load test, NL & BR test, DC & AC, Resistance measurement, Insulation measurement, starting test, Temp. Rise test, Slip measurement, HV test, testing on auxiliaries, Vibration Test, Noise level test. Drying out methods / Polarization Index / Hot Temperature measurement Degree of protection (IP Grade) Commissioning steps for Induction motor, Heat Run Test. Commissioning of Induction Generator. Troubleshooting & maintenance of induction motor.

3. **Substation Equipments:**
   Bus bar: Temperature Rise test, Rated short time current test, HV test, Power frequency voltage withstand test, Impulse / surge testing, Vibration.
   Earthing: Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement.
   Isolator Testing: Temp. Resistance test, Short circuit test, charging current making & breaking test, Inductive current making & breaking test.
4. **Circuit Breaker: Testing of HV/ LV circuit breaker:** No load Mechanical Operation, Mechanical endurance test, Temp. Rise test, Impulse & surge testing, short time current test. Short circuit making & breaking test, Line Charging current making& breaking test, Cable charging & capacitor bank making & breaking test, Out of phase switching, Short line fault test, and Electrical & Mechanical endurance test for LT switch gear like MCB / MCCB / ELCB etc. C.T. & P.T. Testing, Relay testing, Coupling capacitors, Station Batteries for D.C. Supply, Fire Shifting Equipments. Testing & Commissioning of Lightning Arrestor, Substation Commissioning by Thermograph. Troubleshooting & maintenance of circuit breakers
5. **DC Machine: Testing:** Voltage drop test or bar to bar test, Load test, Open circuit & magnetizing test, Insulation resistance, Starting performance, Dielectric test. Swinburne's test, Hopkinson's test, Field test, Separation of losses in DC shunt machine. Temperature rise test & Heat run test Drying out process, Commissioning steps for DC machines Troubleshooting & maintenance.
6. **Synchronous machine: Testing** OC & SC test, Characteristics, Loss measurement, Temp. rise test, Over speed test, HV testing, Insulation resistance wave form interference, DC & AC Resistance of armature & field winding measurement, Dielectric testing on armature & field winding, Mechanical balance, Magnetic balance, Current balance, Phase sequence, Harmonic analysis, reactance & time constant, Speed torque current , Vibration & noise measurement, SC test, Synchronizing circuit testing, Testing of voltage regulators, Excitation circuit testing, Voltage recovery test, Retardation test on load / no load. Drying out procedure Commissioning steps for synchronous machines, Troubleshooting & maintenance.
7. **Commissioning of transmission line & Cable** De-rating of cable capacity, HV test, AC & DC Resistance check, Insulation resistance, Impedance measurement, Location finding technique for fault in underground cables (Murray loop test & Varley loop test), Testing of open circuit faults in cables. Line charging, loading & Dropping.

B. <u>Lesson Planning</u>

SR No.	Lectures (Hours)	Weight-age in % in Exam	Topic
1	8	20	**Transformer:** Testing procedure for HV testing, Phase shifting/ phase group, Radio interference, Ratio Test, Load loss, Separate source voltage testing, Induced voltage testing, Impulse & Surge testing, Noise level & vibration testing,

			Short circuit withstand test, Tan Delta test, Core insulation voltage test, Measurement of impedance, Testing of auxiliaries & safety device, Oil testing, Classification of Testing methods, Testing of bushing. DC & AC Resistance measurement, Temp. Rise test, Short circuit test, Dielectric test, Partial discharge, Insulation resistance testing, Polarity testing, Short time current rating, Impulse & surge testing, Determination of error & accuracy class, Power frequency voltage withstand test, over voltage inter-turn test. Determination of polarization index for transformer. Drying out procedure for transformer. Commissioning steps for transformer, Purification & Filtration Procedure for Transformer oil. Troubleshooting & Maintenance of transformer
2	8	20	**Induction Motor: Testing (3-phase & 1-phase):** Hammer test, Testing against variation of voltage/current/frequency, Load test, NL & BR test, DC & AC, Resistance measurement, Insulation measurement, Starting test, Temp. Rise test, Slip measurement, HV test, Testing on auxiliaries, Vibration Test, Noise level test. Drying out methods / Polarization Index / Hot Temperature measurement Degree of protection (IP Grade) Commissioning steps for Induction motor, Heat Run Test. Commissioning of Induction Generator. Troubleshooting & maintenance of induction motor.
3	8	20	**DC Machine: Testing:** Voltage drop test or bar to bar test, Load test, Open circuit & magnetizing test, Insulation resistance, Starting performance, Dielectric test. Swinburne's test, Hopkinson's test, Field test, Separation of losses in DC shunt machine. Temperature rise test & Heat run test Drying out process, Commissioning steps for DC machines Troubleshooting & maintenance.
4	8	20	**Synchronous machine: Testing** OC & SC test, Characteristics, Loss measurement, Temp. rise test, Over speed test, HV testing, Insulation resistance wave form interference, DC & AC Resistance of armature & field winding measurement, Dielectric testing on armature & field winding, Mechanical balance, Magnetic balance, Current balance, Phase sequence, Harmonic analysis, reactance & time constant, Speed torque current , Vibration & noise measurement, SC test, Synchronizing circuit testing, Testing of voltage regulators, Excitation circuit testing, Voltage recovery test, Retardation test on load / no load. Drying out procedure Commissioning steps for synchronous machines, Troubleshooting & maintenance
5	4	6	**Substation Equipments** **Bus bar:** Temperature Rise test, Rated short time current test, HV test, Power frequency voltage withstand test, Impulse / surge testing, Vibration. **Earthing:** Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement **Isolator Testing:** Temp. Resistance test, Short circuit test, charging current making & breaking test, Inductive current making & breaking test.
6	6	10	**Circuit Breaker: Testing of HV/ LV circuit breaker:** No load Mechanical Operation, Mechanical endurance test, Temp. Rise test, Impulse & surge testing, short time current test. Short circuit making & breaking test, Line Charging current making& breaking test, Cable charging & capacitor bank making & breaking test, Out of phase switching, Short line fault test, and Electrical &

			Mechanical endurance test for LT switch gear like MCB / MCCB / ELCB etc. C.T. & P.T. Testing, Relay testing, Coupling capacitors, Station Batteries for D.C. Supply, Fire Shifting Equipments. Testing & Commissioning of Lightning Arrestor, Substation Commissioning by Thermograph. Troubleshooting & maintenance of circuit breakers
7	3	4	**Commissioning of transmission line & Cable** De-rating of cable capacity, HV test, AC & DC Resistance check, Insulation resistance, Impedance measurement, Location finding technique for fault in underground cables (Murray loop test & Varley loop test), Testing of open circuit faults in cables. Line charging, loading & Dropping.
	45	100	

C. INSTRUCTIONAL METHOD AND PEDAGOGY (Continuous Internal Assessment (CIA) Scheme)

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lectures, practicals and Tutorial which carries 05 Marks.
- At regular intervals assignments is given. In all, a student should submit all assignments of 05 marks each.
- Classroom participation and involvement in solving the problems in Tutorial rooms carries 05 Marks.
- Viva Voce will be conducted at the end of the semester of 05 Marks.
- One internal exam of 30 marks is conducted as a part of mid semester evaluation.
- Experiments shall be performed in the laboratory related to course contents.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concept being taught in lectures.

D. <u>Suggested Experiments:</u>

- To study various connections and vector diagrams of three phase transformer
- To study additive and subtractive polarities of two winding Transformer
- To measure the dielectric strength of transformer oil.
- To study about drying out procedure for Electrical Machines.
- To perform the polarity test on Current Transformer
- To study methods of measuring earthing resistance and measure Earth resistance with Earth Tester.
- To measure insulation resistance with the help of Megger.
- Study of different faults in a 3-∅ induction motor. Discuss the various reasons and pinpoint the location of the fault.
- Study of different faults in a DC Machine. Discuss the various troubleshooting.
- Study of different faults in a Synchronous Machine. Discuss the various reasons and pinpoint the location of the fault.

E. Students Learning Outcomes

On successful completion of the course

- The student can be acquired the basic knowledge of Testing and commissioning of electrical equipments.
- The students will be able to effectively understand faults and tackle them for electrical equipments.
- The students will be able to maintain electrical equipments regular interval**.**

Reference books:

1. Testing, Commissioning & maintenance of electrical equipment By S. S. Rao, Khanna publications
2. The commissioning of Electrical Plant by RCH Richardson (Chapman & Hall)
3. Installation, Commissioning & Maintenance of Electrical Equipments by Tarlok Singh, S. K. Kataria & Sons.
4. Electrical Installation, Testing and Commissioning handbook, Andrew H.