

<b>Faculty:</b>	Construction, Engineering & Transport (CET)	<b>College:</b>	Ultimo
<b>Teaching Section:</b>	Electrical Trades		
<b>Qualification Number and Name:</b>	UEE62111 Advanced Diploma of Engineering Technology-Electrical/ UEE62211 Advanced Diploma of Electrical Engineering		
<b>Unit of Competency Number and Name:</b>	<b>UEPOPS456A Perform switching to a switching program</b>		

## SKILLS DEVELOPMENT TASKS AND FORMATIVE ASSESSMENT SYSTEM

- The students will be provided with class tutorials in which they will have to answer the series of questions which can systematically develop the power system operation/ Perform Switching to a Switching Program Tasks.

Copy and paste the following table for each element as required

Elements & Performance Criteria			Assessment event(s)		
Element(s)	PC No	Performance Criteria (PC)	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
1.Prepare to diagnose and rectify faults	1.1	OHS procedures for a given work area are identified, obtained and understood.	Q1,2,3 of IS69 assessment Mapping.pdf (Page 1)		
	1.2	Established OHS risk control measures and procedures in preparation for the work are followed.	Q 4,5,6,7 of IS69 assessment Mapping.pdf (Page 2)		
	1.3	Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with appropriate personnel			Advanced Diploma in Electrical Engineering Exercises Page 2 Q8 to 11)
	1.4	The extent of faults is determined from reports and other documentation and fro discussion with appropriate personnel			Advanced Diploma in Electrical Engineering Exercises Page 124)Q10,11 Advanced Diploma in Electrical Engineering

Elements & Performance Criteria			Assessment event(s)		
Element(s)	PC No	Performance Criteria (PC)	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
					Exercises Page 131) Q5 to 15
	1.5	Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved on the work site	Advanced Diploma in Electrical Engineering Exercises Page 133) Q23 to 30		
	1.6	Tools, equipment and testing devices needed to diagnose faults are obtained in accordance with established procedures and checked for correct operation and safety.			Advanced Diploma in Electrical Engineering Exercises Page 133) Q38 to 43
2.Diagnose and rectify faults	2.1	OHS risk control measures and procedures for carrying out the work are followed.	<b>As per 1.3</b>		
	2.2	The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures	Advanced Diploma in Electrical Engineering Exercises Page 126) Q35 to 37		
	2.3	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures	<b>As per 1.3</b>		
	2.4	Logical diagnostic methods are applied to diagnose energy supply apparatus faults employing measurements and estimations of system operating parameters referenced to system operational requirements.			Advanced Diploma in Electrical Engineering Exercises Page 128) Q57 to 60

Elements & Performance Criteria			Assessment event(s)		
Element(s)	PC No	Performance Criteria (PC)	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
	2.5	Suspected fault scenarios are tested as being the source of system problems	Q24,25 of IS69 assessment Mapping.pdf (Page 9+10)		
	2.6	Cause of the faults are identified and appropriately competent persons are engaged to rectify the fault where it is outside the scope of the control system			Advanced Diploma in Electrical Engineering Exercises Page 131)Q14 to 16
	2.7	Faults in the apparatus components are rectified to raise energy supply apparatus to its operation standard.			Advanced Diploma in Electrical Engineering Exercises Page 132) Q19 to 21
	2.8	Apparatus is tested to verify that it operates as intended and to specified requirements	Advanced Diploma in Electrical Engineering Exercises Page 134) Q45,46		
	2.9	Decisions for dealing with unexpected situations are made from discussions with appropriate persons and job specifications and requirements	As per 1.3		
	2.10	Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.			Advanced Diploma in Electrical Engineering Exercises Page 211) Q50 to 54
	2.11	Diagnosis and rectification activities are carried out efficiently without unnecessary waste of materials or damage to apparatus and the surrounding environment or services and using sustainable energy practices.			Advanced Diploma in Electrical Engineering

Elements & Performance Criteria			Assessment event(s)		
Element(s)	PC No	Performance Criteria (PC)	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
					Exercises Page 128) Q54 to 59
3.Complete and report fault diagnosis and rectification activities	3.1	OHS work completion risk control measures and procedures are followed.	As per 1.3		
	3.2	Work site is made safe in accordance with established safety procedures.	As per 1.3		
	3.3	Rectification of faults is documented in accordance with established procedures.	Test 1 All Questions		
	3.4	Appropriate person or persons notified, in accordance with established procedures, that the system faults have been rectified	Test 2 All Questions		

Add rows to the following table as required

Performance Evidence	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
Receiving end voltage comparison between short/ medium and long transmission lines		EP1	
Long transmission line PI equivalent circuit		EP2	
Long transmission line T equivalent circuit		EP3	
Transmission line efficiency/ Transformer effect on line efficiency		EP4	

Performance Evidence	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
Reactive power and power factor improvement		EP5	
PF effect on line current		EP6	
Corona Video		EP7	
Phase sequence measurement		EP8	
Underground cable capacitance test		EP19	
High tension line design		EP20	
Line insulator test & capacitance grading		EP21	
Voltage profile chart of distribution system		EP22	
Load centre-Power loss comparison		EP23	

Add rows to the following table as required

Knowledge Evidence	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
T1 Control of voltage encompassing			Advanced Diploma in Electrical Engineering Exercises Page 122) Q40 ,43,44
T2 The importance of the location in the system of voltage control devices			Advanced Diploma in Electrical Engineering Exercises Page 122) Q41,42
T3 The use of graphical methods to calculate the size of VAr regulating plant			Advanced Diploma in Electrical Engineering Exercises Page 132) Q19 to 21

Add rows to the following table as required

Assessment Conditions	Assessment event 1 Written Test	Assessment event 2 Practical & Observation	Assessment event 3 Assignment
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T4 Control of power			Advanced Diploma in Electrical Engineering Exercises Page 133) Q23 to 30
T5 The relationship between power and frequency			Advanced Diploma in Electrical Engineering Exercises Page 130) Q1,2,3,4
T6 Types of communication systems			Advanced Diploma in Electrical Engineering Exercises Page 133) Q23 to 30
T7 Transient over-voltages in power systems			Advanced Diploma in Electrical Engineering Exercises Page 133) Q40
T8 Factors leading to the generation of corona			Advanced Diploma in Electrical Engineering Exercises Page 131) Q5 to 10
T9 Power System Protection			Advanced Diploma in Electrical Engineering Exercises Page 133) Q 38 to 43

## **1 Prepare to diagnose and rectify faults**

1.1 OHS procedures for a given work area are identified, obtained and understood.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 3 -Q15+16

[www.electricaldiploma2013.webs.com](http://www.electricaldiploma2013.webs.com) Then access Click **HERE** to download the Exercises

[http://www.mongroupsydney1.com/Advanced Diploma in Electrical Engineering Exercises EE011.pdf](http://www.mongroupsydney1.com/Advanced%20Diploma%20in%20Electrical%20Engineering%20Exercises%20EE011.pdf)

Relevant Instruction Lessons

### **Study Option (1)**

Guided study (Online)Resources+Online exercises+Online Practicals

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### **Youtube Videos for Electrical Engineering Lessons**

<http://www.mongroupsydney1.com/youtubevideos.htm>

Q1.Describe the risks and dangers in power station and outline the recommended safety

Q2.equipments and emergency procedures.

Q3.Outline the process of maintenance work in substation.

1.1 OHS risk control measures and procedures in preparation for the work are followed

Ref-Advanced Diploma in Electrical Engineering Exercises Page 3 -Q17+18 Page 4 Q21+22

Q4. Write down the check list to perform the tasks in substation.



Q5. Write down the safety procedures and methods to assess the risk and to reduce the risk.

Q6..Write down the code of practice for working near exposed main and apparatus.

Q7.Which precautions are to be emphasized when working in substation?

1.3 The likely extent of work to be undertaken is envisaged from reports and/or discussions with appropriate person(s)

Q8. Write down the risk reduction procedures in maintenance work to discuss with work manager. (Ref-Advanced Diploma in Electrical Engineering Exercises Page 2 Q12)

1.2 Advice is sought from the work supervisor to ensure the work is coordinated effectively with others.

1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with appropriate personnel.

Answer the following questions to seek the advice from work supervisor in the following aspects.

Q9. What are the risks?

Q10.How are the risks classified?

Q12.How can the risk be evaluated?

Q12.How will you manage the risk? Ref-Advanced Diploma in Electrical Engineering Exercises Page 2 Q8 to 11)

1.4 The extent of faults is determined from reports and other documentation and from discussion with appropriate personnel  
Ref-Advanced Diploma in Electrical Engineering Exercises Page 124)

The following questions are developed to assess the fault.

(17) Power transformer protection

Slide 1+3

Q10.What are the types of faults in power transformer?

Slide 2

Q11.What are the causes of transformer faults.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 131)

(35) Corona+ short circuit current+ Transient fault + voltage surge+ Reflection

Slide 1

Q5.What is corona?

Q6.Explain the concept of disruptive critical voltage.

Slide 2+3

131

Q7.How does corona happen? And express the factors related to occurrence of corona.

Slide 4

Q8.Write the formula to calculate break down voltage

Slide 5

Q9.What are the disadvantages of corona?

Slide 6+7

Q10.What are to be done to prevent the corona?

Slide 8

Q11.Sketch the short circuit current in AC network.

Slide 10

Q12.Sketch the connection of current limiting reactor.

Slide 11

Q13.Sketch the power response by line voltage surge graph.

Slide 12

Q14.What are the causes of voltage surge?

Q15.Write the equation for switching e.m.f velocity.

1.5 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved on the work site

Ref-Advanced Diploma in Electrical Engineering Exercises Page 133)

The practice questions are organized to find out the protection system equipments and materials together with relevant theory

(38)Computerised control + Supervisory control+ IP based network + Digital control

Slide 1

Q23.Explain the application of telecom system in power line with sketch.

Slide 2+4+5

Q24.Explain telecom based differential protection system.

Slide 6

Q25.Explain distributed real time computer network for power system.

Slide 7+8+9

Q26.Explain remote and computer control in power system.

Slide 10.

Q27.Why is phase comparison relaying provided?

Q28.Sketch ADC control.

133

Slide 11+12+13+14

Q29.Sketch internal & external fault discrimination diagram.

Slide 15+16

Q30.Explain the application of computerised control and power network.

1.6 Tools, equipment and testing devices needed to diagnose faults are obtained in accordance with established procedures and checked for correct operation and safety

Ref-Advanced Diploma in Electrical Engineering Exercises Page 133)

(39) Metering + Location of CT+ Power Surge +Grounding +Harmonic

Slide 1

Q38.Sketch the basic metering arrangement in substation.

Slide 9

Q39.Sketch the location of CT in power line

Slide 10

Q40.Explain power surge protection for transmission line.

Slide 11+12

134

Q41.Explain grounding in power system.

Slide 13+14+15

Q42.A square wave has amplitude of 70V , fundamental is 90V. Calculate (a) Effective value of square wave. (b) Effective value of fundamental (c) Total harmonic distortion

Slide 6

Q43.Sketch the diagram of harmonic filter.

## 2 Diagnose and rectify faults

2.1 OHS risk control measures and procedures for carrying out the work are followed.

As per 1.1 to 1.3

2.2 The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 126)

Live testing of protective relay system and depermination of characteristics and relevant questions are arranged to provide this competency component.

Slide 21

Q35.Sketch the typical protection scheme

Slide 22

Q36.Sketch the computer flow chart for power system protection.

Slide 23

Q37.Sketch electronic control system for power system protection.

2.3 Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures

As per 1.3

2.4 Logical diagnostic methods are applied to diagnose energy supply apparatus faults employing measurements and estimations of system operating parameters referenced to system operational requirements.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 128)

Slide 5

Q57.Explain busbar protection with sketch

Slide 6

Q58.Write line & busbar protection with sketch.

Slide 7

Q59.Sketch the operation of digital relay.

Slide 8+9

Q60. Sketch the flow chart for the software of digital protective relay.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 130)

Slide 7

Q4. Write the machine angular acceleration formula

2.5 Suspected fault scenarios are tested as being the source of system problems..

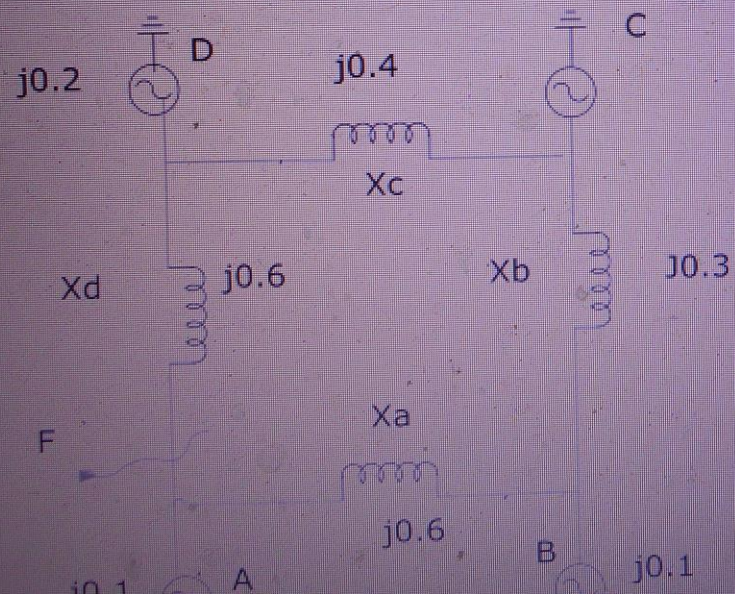
Ref-Advanced Diploma in Electrical Engineering Exercises Page 204/205)



(12) Per unit system

Slide 1+2+3+4+5+6

Q24. In the given network, three phase fault occurs at point F. Calculate fault MVA per unit value of reactance. All refer to 200MVA base, resistance may be neglected.

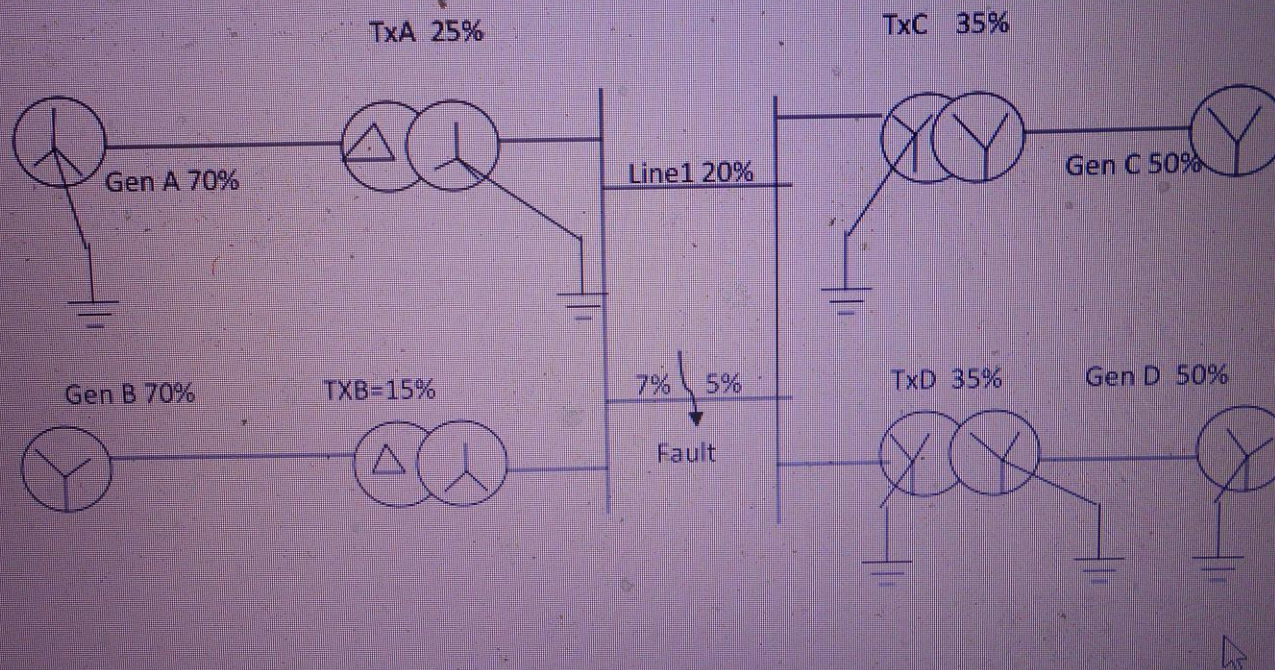




### (13) Fault calculation

Slide 1 to 15

Q25. Draw the positive, negative and zero sequence equivalent diagram for the given power system.



2.6 Cause of the faults are identified and appropriately competent persons are engaged to rectify the fault where it is outside the scope of the control system

Ref-Advanced Diploma in Electrical Engineering Exercises Page 131)

Slide 12

Q14. What are the causes of voltage surge?

Q15. Write the equation for switching e.m.f velocity.

Slide 13

Q16. Sketch voltage surge & protection diagram .

2.7 Faults in the apparatus components are rectified to raise energy supply apparatus to its operation standard.

Ref-Advanced Diploma in Electrical Engineering Exercises Page 132)

(36) Reactive power control static VAR compensation

Slide 1+2+3

132

Q19. How will you connect the reactive power control capacitor bank to three phase system.

Q20. Sketch synchronous motor reactive power control diagram.

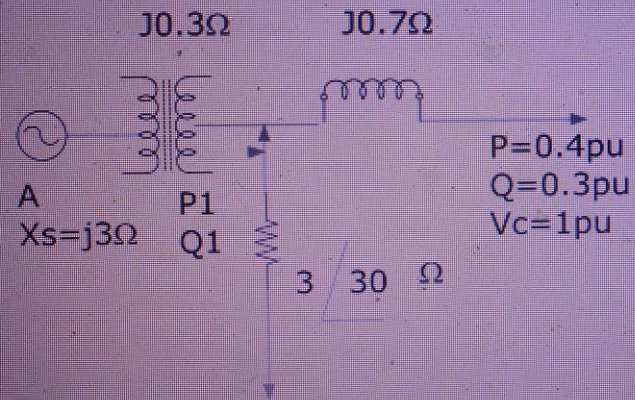
Q21. Explain how reactive power is controlled by static VAR compensation system.



(37) Line power flow receiving end voltage comparison.

Slide 1+2

Q22.



Calculate (a)  $V_A$  (b) current flow to Z

2.8 Apparatus is tested to verify that it operates as intended and to specified requirements

Ref-Advanced Diploma in Electrical Engineering Exercises Page 134)

Slide 4

Q45. Sketch (a) Arcing horn (b) Lightning arrester (c) Surge absorber

Slide 5

Q46. Sketch the arrangement of instrument in sub station.

2.9 Decisions for dealing with unexpected situations are made from discussions with appropriate persons and job specifications and requirements.

As per 1.3

2.10 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.

### Ref-Advanced Diploma in Electrical Engineering Exercises Page 211)

(11) Change control

Slide 1

Q50. Describe the overview of change control system.

Slide 2

Q51. Explain the establishment of contracts

Slide 3

Q52. Outline the project control system responding the disturbances.

Slide 4

Q53. Sketch the procedure for preparing quality manual.

Slide 5+6

Q54. Explain management leadership.

### Ref-Advanced Diploma in Electrical Engineering Exercises Page 130)

Original design

Q1. Generator A with 100MW, 4% drop and generator B of 200 MW 4% drop. Are supplying the 200MW load. Calculate their load share.

But in reality, the situation is changed to

Q2. Generator A with 200MW 6% drop and generator B with 400MW 7% drop are supplying 300MW load, calculate their load share.

Provide the solution

2.11 Diagnosis and rectification activities are carried out efficiently without unnecessary waste of materials or damage to apparatus and the surrounding environment or services and using sustainable energy practices

Ref-Advanced Diploma in Electrical Engineering Exercises Page 128)

To convert the analog relaying system to digital relay system, the dismantling of origin components and assembly of new system components are to be done. The following questions and activities provide this competency component.

(29) Digital relay+ Telecommunication for protection

Slide 1

Q54.What is digital relay?

Slide 2+4

Q55.Sketch the flow diagram of digital relay operation.

Slide 3+4

Q56.Sketch DAC system

Slide 5

Q57.Explain busbar protection with sketch

Slide 6

Q58.Write line & busbar protection with sketch.

Slide 7

Q59.Sketch the operation of digital relay.

### 3 Complete and report fault diagnosis and rectification activities

3.1 OHS work completion risk control measures and procedures are followed.

As per 1.3

3.2 Work site is made safe in accordance with established safety procedures.

As per 1.3

3.3 Rectification of faults is documented in accordance with established procedures.

3.4 Appropriate person or persons notified, in accordance with established procedures, that the system faults have been rectified

**Work performance + Practical Instruction Back up**

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Refer Power System Practical

**Part 1: Operational Study**

Lab No	Name of Practical	Equipments	Assessment
	<u>Group 1 Power &amp; Line</u>		
EP1	Receiving end voltage comparison between short/ medium and long transmission lines	distribution system types	Circuit interpretation, connection, data collection, calculation, graph sketch, report presentation, conclusion
EP2	Long transmission line PI equivalent circuit	overhead systems	As above
EP3	Long transmission line T equivalent circuit	distribution system types	As above
EP4	Transmission line efficiency/ Transformer effect on line efficiency	energy metering • demand meters	As above
EP5	Reactive power and power factor improvement	energy metering • demand meters	As above
EP6	PF effect on line current	energy metering • demand meters	As above
EP7	Corona Video	• surge protection	Report presentation, conclusion

EP8	Phase sequence measurement		Competency assessment
	<u>GROUP 2- Protection equipments</u>		
EP9	Connection of relay protection scheme & protective equipments by using one line diagram (Circuit interpreting & connection competency development without electrical supply)	protection equipment and systems	Competency assessment
EP10	Current transformer & potential transformer connection & ratio test	current transformers • potential transformers	Circuit interpretation, connection, data collection, calculation, graph sketch, report presentation, conclusion
EP11	Over current relay characteristics	protection equipment and systems • over-current protection	Circuit interpretation, connection, data collection, calculation, graph sketch, report presentation, conclusion
EP12	Electronic relay test	conventional relays • electronic relays	As above
EP13	Study of various protective relays used in industry through trade references	• earth fault protection • differential protection busbar protection • surge protection • conventional relays	Research, report presentation
	<b>Group 3- Supply System</b>		
EP19	Underground cable capacitance test	underground systems	Circuit interpretation, connection, data collection, calculation, graph sketch, report presentation, conclusion
EP20	High tension line design	• overhead systems	Design project
EP21	Line insulator test & capacitance grading	• overhead	Circuit interpretation, connection, data collection, calculation, graph

		systems	sketch, report presentation, conclusion
EP22	Voltage profile chart of distribution system	<ul style="list-style-type: none"> <li>• voltage regulation equipment</li> <li>• on load tap changers</li> </ul>	As above
EP23	Load centre-Power loss comparison	<ul style="list-style-type: none"> <li>• distributor equipment</li> </ul>	As above
EP30	Transformer polarity test	<ul style="list-style-type: none"> <li>• distributor equipment</li> </ul>	As above
EP42	Maximum power transfer theorem with power circuit	<ul style="list-style-type: none"> <li>• load control</li> </ul>	As above
EP43	Load flow study	<ul style="list-style-type: none"> <li>• load control</li> </ul>	As above
EP45	Trade reference study, switch board, busbar, insulator, circuit breakers	reclosers / sectionalisers.	As above

2.10 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.

2.11 Diagnosis and rectification activities are carried out efficiently without unnecessary waste of materials or damage to system and the surrounding environment or services and using sustainable energy practices.

**General faults including: open-circuit; short-circuit; incorrect connections; insulation failure; unsafe condition; apparatus/component failure; related mechanical failure for the equipments in the range**

**(2)Explore some of the faults in power system/ energy supply that can be rectified only by utilizing para-professional knowledge background and how the arranged simulated practical can provide the hand on experience and work performance for the students and how it is different from the performance only based on trade level activities.**

In range of performance, it outlines the real equipments used in the industry. There will be the arguments that the setting of practical in lab room only includes rheostat, resistor, varic, capacitor etc. How it meets the outlined competencies?

To exactly find out and rectify the faults in energy supply system , the tasks and complexity level more than the trade level- (check the continuity, check the connection, visual inspection, testing and measurement )will be included.

The following is the various power system faults which I draw out from my power engineer work records that the technical knowledge higher than trade level is required to successfully rectify the fault and determine the appropriate solutions. In the table, I summarize how the fault is , caused, background theory, how the person who knows the theory will do, how the person who does not know the theory will do and how my simulated practical / and practical related background theory will assist to develop the fault finding skill.

Typical fault	Cause	Related Theory	How the person who does not know the theory will do	How the person who knows theory will do	Name of simulated practical	How to develop the skill
(1)In reticulation system, there is abnormally different in voltages	Abnormal resistance. Wrong cable selection. Abnormal circuit configuration	Voltage profile chart.	May give he other idea to change the load	Measure voltage, sketch the voltage profile chart. Then identify the portion of the circuit.	EP 23 Voltage profile chart	Develop the analytical skills to identify the fault point
(2)Line conductor slips from the pin insulator	Line deviation is too high, combination of wind, conductor tension will take away the conductor from pin insulator	Line deviation angle calculation	Will reinstall the line. After some period, he same thing will happen again	Will examine line deviation angle. Tension, wind force. Will rearrange the line or provide shackle insulator	Theory instruction. Line deviation	Develop the problem solving skill on line construction.
(3)Conductor sag too low. Hit by traffic and then broken	Sag calculation. Wrong tension, safety factor, weight	Sag/ line design	Pull up the cable. After some time, it will fall again	Will examine the related parameters and find the way	EP 20 High Tension Line Design	Develop the skill on line design and to know the technical factors for sag.
(4)Discharge current flows out from underground insulator and cause the injury	UG cable capacitance. Charging current	UG Cable capacitance test	Will think about current flow, leakage etc.	Will examine the UG cable capacitance and produce the procedure for discharging	EP 19 Underground cable capacitance test	Develop the skill in UG cable testing focus on capacitance and estimate the amount of charging current
(5)Line pole broken without natural disaster	In appropriate pole strength	Pole mechanical design	Will erect the pole. Some time after, broken gain	Will examine he tension, wind force, conductor weight, then will calculate the pole strength and select appropriate diameter of pole and appropriate pole material	Pole mechanical design lesson + EP 20 High tension line design	Develop the skill on line design and to know the technical factors for pole.

## 2 Complete and report fault diagnosis and rectification activities.

### 3.1 OHS work completion risk control measures and procedures are followed.



### 3.2 Work site is made safe in accordance with established safety procedures.

As per 1.3

### 3.3 Rectification of faults is documented in accordance with established procedures.

### 3.4 Appropriate person or persons notified, in accordance with established procedures, that the system faults have been rectified.

Fault	Reason	Related theory	The person who does not know the theory will do	The person who knows the theory will do	Related Practical	Development of skill
(6)There are too much power loss. Line efficiency is poor	If all connected loads are all right, wrong location of power station/ load centre	Load centre study	Will not take account on load centre	Will take account on load centre	EP23 Load centre power loss comparison	How the location of supply source affect line losses/ efficiency and % voltage regulation
(7)Problem with UG cable joint	Wrong method in UG cable joining	UG cable joining methods. Theory study			UG cable joining method in my prepared 7762 AA Electrical Distribution textbook	UG cable joining methods. Theory PLUS photographs
(8)Generator got motor action. Reverse power relay cuts off	Out of synchronism. Up to 180 degree out of phase	Synchronizing	Will neglect synchronism. Just run and switch on	Will focus on synchronizing process. Avoid reverse power relay operation	Synchronizing	Synchronism, generator parallel operation requirement practical knowledge development.
(9)Generator vibration/ hunting	Stability concept	System stability	Do not care on machine hunting. Will continue to run . As consequence, face the short life of bearing/ shaft	Will take care on transient and steady state system stability and prevent the hunting	Moment of inertia/ machine stability	Moment of inertia/ machine stability practical knowledge development.
(10)Relay operates on fault. But the system loss the synchronism	System stability/ critical fault clearing angle aspect.	System stability/ critical fault clearing angle	Do not care on the relay setting to provide both fault protection and	Will set the proper relay setting to maintain the stability	Critical fault clearing angle. Equal area criteria	Critical fault clearing angle. Equal area criteria practical knowledge



			maintain the system stability. Re-synchronize the generators when ever the relay operates			development.
(11) Line reactive power too much. The equipment capacity is unnecessarily increased	Problem related to load flow	Load flow study	Will not take account on load flow concept.	Take account on load flow and optimize the loading	EP 42 Maximum power transfer theorem  EP43 Load flow study	Develop the load flow concept and practical optimizing skill
(12)There is nothing wrong with the line but the transformer placed near the switch heat up and cooked	Switching surge	Switching voltage surge	Just replace the transformer. After some time, the same problem will be faced	Take account on switching voltage surge and plan to install the surge diverter.	Switching voltage surge	Switching voltage surge practical knowledge development.
(13)Light radiated from the power line. Too much power loss and high interference to telecom line	Corona	Corona study	Will consider the ACT OF GOD	Will find the way to reduce corona such as application of hollow conductor to increase diameter of conductor to raise the critical voltage level	EP 7 Corona video	How corona occurs and find the way to prevent .
(14) Control telecommunication for power line down, no relay operates	Application of telecommunication system in power system operation	Application of telecommunication system in power system operation 7762AG Power System Operation	Will not be aware of the role of telecommunication system	Will check the function of telecom equipment for power system control and protection and perform the preventive maintenance	Application of telecommunication system in power system operation	Web based control/ IP based control and telecomm: concepts practical knowledge development.
(15)Too much flickering of lamps	Harmonics	Harmonics in power system	Will not know what happens	Will check the harmonics source/ increase the size of neutral wire to allow the harmonics current flows	Harmonic source scope observation	Development of identifying the harmonics
(16)Lightning strike	Lightning arrester	Lightning arrester	Will reinstall LA. But not sure it will be safe or not.	Will check the coverage provided by lightning arrester	Lightning arrester study	Lightning arrester practical knowledge development.
(17)Earth fault/ earth leakage can not be protected	Grounding in power system	Grounding in power system 7762AE Power System Protection	--	Will measure the ground resistance, will implement the additional ground connections	Power system grounding study	Power system grounding practical knowledge development.
(18)Occurance of over	Over current	Over current relay	Will not exactly know	Will set/ adjust the	EP11 Over current	Practical skill

current	protection	7762AE Power System Protection	how to set/ adjust the over current relay	over current relay	relay characteristics	development in over current relay
(19)Earth leakage fault	Earth leakage protection	Earth leakage protection 7762AE Power System Protection	Will not exactly know how to set/ adjust the earth leakage relay	Will set/ adjust the earth leakage relay/ CT arrangement	CT arrangement for earth leakage fault & fault in protected zone	Practical skill development in earth leakage fault protection
(20)Transformer protection	Differential relay	Differential relay	Will not exactly know how to set/ adjust the differential relay	Will set/ adjust the differential relay	CT arrangement for fault in protected zone	Practical skill development in differential protection
(21)Line is protected by differential/ over current relay. But it is not effective when the load are fed from some part of the line	Distance relay	Distance relay	Will not exactly determine the reason why and how to change the protection system	Will change the protection system and will calculate earth fault impedance	Earth fault calculation	Problem solving skill development in earth fault calculation
(22)Fault happens but the relay can not provide the effective protection	CT/ PT ratio for relay	Relay protection scheme	Will not exactly determine the reason why and how to change the protection system	Will adjust CT PT ratio at the simulated fault situation and will adjust the relay setting appropriately	EP9 Connection of relay protection scheme & protective equipments by using one line diagram (Circuit interpreting & connection competency development without electrical supply)  EP10 Current transformer & potential transformer connection & ratio test	Practical skill development in CT PT ratio adjustment
(23) I accidentally open the CT secondary and it got explosion	Current transformer	Current transformer		Will make sure not to open circuit the CT secondary	EP10 Current transformer & potential transformer connection & ratio test	Develop the skill on CT/ PT connection & applications.

(24) we use old type gravity relay, it does not provide the effective protection	Restraining system of relay	Relay types & characteristics		Will make sure to correctly arrange the relay position	EP13 Study of various protective relays used in industry through trade references	Knowledge development on various protective relays used in industry through trade references
(25) Relay operates at wrong current	Operation/ setting of relay	Relay types & characteristics	Trial error approach will be used	Will make sure to correctly arrange the relay setting	EP11 Over current relay characteristics	Practical skill development in over current relay
(26)In power transformer protection. Transformer is Star/Delta connection. All relay settings are correct. But relay wrongly operates. I checked all continuity. Every thing all right	Transformer Star Delta & relay star/delta matching	Star delta vector diagram. Transformer star side –Relay delta & transformer delta— Relay star	Will not know what happens and how to rectify the fault	Will check the connection and will consider the vector difference causes the wrong operation	EP10-CT & PT connection/ ratio check	Practical skill development in CT/PT Connection
(27)Regulator is set to meet the system voltage condition. But later time, it is blown out	Voltage ratio/ regulator setting	Voltage regulator	Will emphasize in solving the problem for a short moment. Will not consider the long term impact	Will consider whether the setting to upgrade the voltage will impact on future system voltage change	EP22 Voltage profile chart of distribution system	The skill training to develop the judgment of voltage level and future impact
(28)Fault spread from one busbar to another busbar	Busbar arrangement/ sectionalization	Busbar arrangement	Will assemble he busbar to install the equipment, will not consider how the arrangement can contribute the spread of fault	Will consider the way to insert section circuit breakers	Busbar layout/ arrangement study	Busbar arrangement sketch/ plan practice development
(29)Equipment suffers over voltage and blown out after the capacitor value is changed for PF improvement	Inappropriate capacitor setting. Cause of overvoltage. Vector diagram	PF improvement/ Capacitive reactance effect on load	Will only see the way to improvement the PF. Will not know the consequences	Will possess the knowledge of capacitor impact on load voltage and will take account on optimal setting of capacitor value	EP5-capacitance effect on line EP6-PF Improvement	PF improvement method is judgment with capacitor effect causes over voltage. This skill is trained.
(30)Directional relay does not work to protect the reverse	Directional relay operation	Study on directional relay.		Wrong connection to direction coil will be identified	EP 13 Protective relays used in industry	Guide to acquire the relevant technical knowledge

power flow						
(31)Voltage flashing over capacitor string	Capacitor string	Study on capacitor string	Will change the capacitor string	Will provide the preventive protection such as arcing horns OR take account on line capacitor grading	EP21 Line insulator capacitance test	Develop the skill to measure line capacitor value . Capacitance grading.
(32)Circuit Breaker itself is blown out	Circuit Breaker capacity	Study on capacity of circuit breaker	Will change CB. After sometime, it will blow up again.	Will consider the CB capacity & possible over current developed in line fault	EP13 Relay & CB used in system Fault current	Develop the skill in fault current estimate and choosing CB capacity
(33)CB too hot and meltdown	CB capacity/ Arc development	Study on capacity of circuit breaker/electric arc	Will change CB. After sometime, it will blow up again.	Will consider the CB capacity & possible over current developed in line fault  Will consider the arc extinguishing methods	EP13 Rely & CB used in system Fault current	Develop the skill in fault current estimate and choosing CB capacity
(34)Need to expand the line in emergency. I am only in-charge	Line design	Line design project	Will not know how to design a line	Will utilize references/ methods to design and construct the line	7762AA Project-Over head line design	Line electrical & mechanical design practice development
(35)HV current flows into LV line	Separation between HV & LV line	Rules & regulations related to line	Will not know the regulation	Will apply the regulation in real wok	7762AA Line pole/ cross arm design and conductor arrangement	Line electrical & mechanical design practice development
(36) Line wire fracture	Sag calculation	Sag calculation/ minimum cable size	Reinstall the line wire. Like part to like part replacement is applied, will use the same size of cable. After sometime, line will break gain	Will consider allowable tension/ minimum conductor size	7762AA Project-Over head line design	Line electrical & mechanical design practice development
(37)Electronics equipment used for line protection is blown up	Voltage surge	Signal condition sub system. Surge filter	Will replace the electronic board. But the same fault happens again	Will consider the cause of surge. Surge filter / absorber/ diverter will be installed	7762AE Line surge/ application of electronic control system	Develop the skill in line surge/ electronic control.
(38) Receiving end voltage is greater than the sending end	Capacitance effect on long line	Long line 7762AG Power System Operation	Will think that the equipments are designed to operate at the sending end voltage level, it will be enough	Will consider the line configuration and will provide the appropriate arrangement for over voltage caused by capacitance effect on long line.	EP2/EP3 Long Line PI & TEE equivalent circuits	Develop the practical skill in determination of possible voltage rise in simulated line model.

(39) Can not run the generators in parallel	Synchronism problem	Synchronizing	Will not properly know the synchronism	Will consider the synchronism	Alternator parallel operation- Procedure	Develop the knowledge in synchronizing
(40) Over current relay is provided to protect the system but it does not work when the ground fault occurs	Characteristics of relays	Relay types and characteristics	Will think that one relay will protect everything	Will select the appropriate relay for appropriate place and protection task	EP13 Study of various protective relays used in industry through trade references	Knowledge development on various protective relays used in industry through trade references

### ASSESSMENT SCHEDULE

Performance Criteria	Assessment 1 Practical		Assessment 2 Theory
	Continuous Observation	Written Assessment as part of Practical	Written Assessment
1.1		X	
1.2		X	
1.3		X	X
1.4		X	X
1.5		X	X
1.6		X	X
2.1		X	
2.2		X	X
2.3		X	X
2.4		X	X
2.5		X	X
2.6		X	X
2.7		X	X
2.8		X	X
2.9		X	X

2.10		X	X
2.11		X	X
2.12		X	X
3.1	X	X	
3.2	X		
3.3	X		
EKAS Assessment		X	X

Method of delivery	Method of collection of evidence
<p>7-Face to face 6-Electronic</p> <p><b><u>Key for delivery mode</u></b>  1-On the job 2-Simulated 3-Blended  4-Self paced 5-Distance 6-Electronic  7-Face to face 8-Other</p> <p><b><u>Detailed explanation</u></b>  Face to face class teaching + Online supplement multimedia notes</p> <p><b><u>Evidence</u></b></p>	<p>A,B,D,E,F,G,L</p> <p>Key for Methods for Collecting Evidence:</p> <p>A-Assignment B-Written Task C-Role play  D-Exam E-Oral questioning F-Simulation  G-Observation H-Work based I-Portfolio  J-Self assessment K-Case study  L-Practical demonstration M-Project  N-Training Record O-Other</p> <p><b><u>Detailed explanation</u></b>  A+B-Test 1, 2, 3, 4  E-Oral question in practical class  F-Simulated practical for line &amp; power system comprising mathematical equations &amp; functions  G-Observe the student's performance in practical class  L-Student practical performance result + report preparation</p>

**Part 1- Evidence of teaching & learning**

**Plan for concurrently delivery**

[www.powerlearning1.zoomshare.com](http://www.powerlearning1.zoomshare.com)

Both digitised notes + multimedia notes including audio files

Notes in USB ( Available on request)

**Part 2- Evidence of lesson planning**

- (1) Delivery & assessment matrix excel form
- (2) Semester plan
- (3) Students study progress plan

( Available on request)

**Evidence Attached**

**Part (1)- Test questions**

2 tests

**Part (2)-Evidence of students participation**

- (1) Signed attendance sheet
- (2) Signed Test attendance sheet
- (3) Sample answer paper & practical report Either hard or scanned copy ( Will be available on request within 6 months of the assessment event
- (4) EBS attendance & grade record

<b>1</b> On the job	<b>2</b> Simulated	<b>3</b> Blended	<b>4</b> Self-paced (facilitated)
<b>5</b> Distance	<b>6</b> Electronic	<b>7</b> Face to Face	<b>8</b> Other (Please specify)

**Key for Methods for Collecting Evidence:**

<b>A</b> Assignment	<b>B</b> Written task	<b>C</b> Role play	<b>D</b> Exam
<b>E</b> Oral questioning	<b>F</b> Simulation	<b>G</b> Observation	<b>H</b> Work based
<b>I</b> Portfolio	<b>J</b> Self assessment	<b>K</b> Case study	<b>L</b> Practical demonstration
<b>M</b> Project	<b>N</b> Training Record Book	<b>O</b> Other (Please specify)	

## Location of Evidences (Table 1)

POWER SYSTEM Youtube video Lessons to provide the sufficient EKAS

G015/ IS67+68+ IS74

Page 196 to 231 of [http://www.filefactory.com/file/cf9bf8f/n/Video\\_Lessons.pdf](http://www.filefactory.com/file/cf9bf8f/n/Video_Lessons.pdf)

### Power System (1)

[G015\(AA\)Lesson 1-Distribution system.zip](#)

<http://youtu.be/VuzjXkRx4UI>

[G015\(AA\)Lesson 2-Demand factor.zip](#)

<http://youtu.be/cUGbxhBT-Dc>

<http://youtu.be/DCCI4cO3Vu8>

[G015\(AA\)Lesson 3-Sag.zip](#)

<http://youtu.be/1s496h-luu8>

[G015\(AA\)Lesson 4-OH Line mechanical design.zip](#)

<http://youtu.be/T0BnyqV9T6E>

[http://youtu.be/hu1TrUv2\\_OY](http://youtu.be/hu1TrUv2_OY)



### [G015\(AA\)Lesson 5-UG Cable.zip](#)

<http://youtu.be/hHCLzMnVmT0>

<http://youtu.be/A5AieaBBZHo>

### [G015\(AA\)Lesson 6-Voltage control.zip](#)

<http://youtu.be/y1vTM5fvfyU>

<http://youtu.be/Z9HBGsVgymA>

### [G015\(AE\)Lesson 1-Power system protection scheme.zip](#)

<http://youtu.be/ihpd3cDAhBU>

<http://youtu.be/EGXkLRM2L9M>

<http://youtu.be/zOIUYQ7OJfs>

### [G015\(AE\)Lesson 2-Differential relay.zip](#)

<http://youtu.be/2iW0oEScMsw>

### [G015\(AE\)Lesson 3-Over current & earth fault protection.zip](#)

<http://youtu.be/hvGjdO9jEhk>

### [G015\(AE\)Lesson 4-Three phase differential relay.zip](#)

<http://youtu.be/2iW0oEScMsw>

<http://youtu.be/VuzjXkRx4UI>

<http://youtu.be/2iW0oEScMsw>

### [G015\(AE\)Lesson 5-Current time grading.zip](#)

<http://youtu.be/r0qkLrmkKsM>

### G015AE Lesson 6

[http://youtu.be/InsTLh7\\_N5k](http://youtu.be/InsTLh7_N5k)

### [G015\(AE\)Lesson 7-CT PT.zip](#)

[http://youtu.be/ZF\\_y65xsM\\_M](http://youtu.be/ZF_y65xsM_M)

### [G015\(AE\)Lesson 8-Distance relay.zip](#)

<http://youtu.be/NKzMVquFLu8>

[http://www.filefactory.com/file/c386a2e/n/G015\\_AE\\_Lesson\\_8-Distance\\_relay.zip](http://www.filefactory.com/file/c386a2e/n/G015_AE_Lesson_8-Distance_relay.zip)

### [G015\(AE\)Lesson 9-Telecom in power protection.zip](#)

<http://youtu.be/9C6oggZAKRg>

[http://youtu.be/XRpffA6hU\\_U](http://youtu.be/XRpffA6hU_U)

<http://youtu.be/X-kz3cyL9fU>

### [G015\(AG\)Lesson 1-Stability.zip](#)

<http://youtu.be/fUyNqcXtBXg>

### [G015\(AG\)Lesson 2-Generator load sharing.zip](#)

<http://youtu.be/A-t7XH4rK4M>

[http://youtu.be/OTsis\\_KIRuk](http://youtu.be/OTsis_KIRuk)

<http://youtu.be/8j1nD9nY2hU>

### [G015\(AG\)Lesson 3-Power Flow.zip](#)

<http://youtu.be/0OzT4Pol-Jc>

[http://youtu.be/fK0wcaTY\\_rw](http://youtu.be/fK0wcaTY_rw)

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### [G015\(AG\)Lesson 4-IP based system.zip](#)

<http://youtu.be/ve5O8K9fL7k>

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### [G015\(AG\)Lesson 5-Surge in power system.zip](#)

<http://youtu.be/6WkezTcOzX4>

### [G015\(AG\)Lesson 6-CTPT Harmonic filter.zip](#)

<http://youtu.be/Uy7q9SsaOYs>

### [G015\(AG\)Lesson 7-Short circuit in alternator.zip](#)

<http://youtu.be/b-46Kvn8kJI>

### G015(AG)Lesson 8-Corona.zip

<http://youtu.be/XYGRAWOqzsc>

### G015(AG)Lesson 9-Power surge.zip

<http://youtu.be/uzFS-otIn-g>

[http://youtu.be/lS\\_Zccy630w](http://youtu.be/lS_Zccy630w)

### G015(AG)Lesson 10-Static Var Compensation.zip

<http://youtu.be/y-of5oLojCU>

### G015(AG)Lesson 11-PF Control+Fuel cell.zip

<http://youtu.be/AXbCcoQeLns>

### G015(AG)Lesson 12-Exercises.zip

<http://youtu.be/nRGScOH9aSM>

## **Power System (2)**

### G037+G038+G039 Lesson 1-Power Flow.zip

<http://youtu.be/mzwGGXRTtw>

### G037+G038+G039 Lesson 2-Site Earthing.zip

<http://youtu.be/PATkXVBF9kc>

<http://youtu.be/H4Dj1K238BE>

### G037+G038+G039 Lesson 3-Power System Control Equipments.zip

<http://youtu.be/JJczbYVWOol>

### G037+G038+G039 Lesson 4-Auxiliary System+Harmonic.zip

<http://youtu.be/5mDNHGFLA0c>

### G037+G038+G039 Lesson 5-Harmonic.zip

<http://youtu.be/n41q4Rmz2p0>

<http://youtu.be/8CelGV5AEIk>

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[G037+G038+G039 Lesson 6-Harmonic Calculation.zip](#)

<http://youtu.be/NHSzu6HkOqI>

<http://youtu.be/fSLrPIC6Mho>

[G037+G038+G039 Lesson 7-Synchronous Generator Loading.zip](#)

[:http://youtu.be/jv1q7Mtg7Gs](http://youtu.be/jv1q7Mtg7Gs)

[http://www.filefactory.com/file/c39be2f/n/G037\\_G038\\_G039\\_Lesson\\_7-Synchronous\\_Generator\\_Loading.zip](http://www.filefactory.com/file/c39be2f/n/G037_G038_G039_Lesson_7-Synchronous_Generator_Loading.zip)

[G037+G038+G039 Lesson 8-Turbine Control+Power Line Earthing.zip](#)

<http://youtu.be/0CvgkmDE3Kw>

[G037+G038+G039 Lesson 9-Insulator.zip](#)

<http://youtu.be/l4jqs8MLBFA>

<http://youtu.be/TiQezIA9Z-c>

[G037+G038+G039 Lesson 10-Reliability of Power System.zip](#)

<http://youtu.be/tlUk3nc1xE>

[G037+G038+G039 Lesson 11-Harmonic Reduction.zip](#)

<http://youtu.be/8dYX-11kRcc>

<http://youtu.be/A684Agej8-w>

[G037+G038+G039 Lesson 12-Grounding + Power Quality.zip](#)

<http://youtu.be/QQPUj3WXJnA>

[G037+G038+G039 Lesson 13-Power Quality.zip](#)

[http://youtu.be/fel7SCb\\_QTY](http://youtu.be/fel7SCb_QTY)

<http://youtu.be/mcK2YhDsnr0>

[G037+G038+G039 Lesson 14-Harmonic Model.zip](#)

<http://youtu.be/dwWBOq-BsLY>

[G037+G038+G039 Lesson 15-Harmonic Losses in Transformer.zip](#)

<http://youtu.be/mwEJgEEgPVc>

<http://youtu.be/1A6FY5f5ijM>

<http://youtu.be/yLiOKy7uJj0>

[G037+G038+G039 Lesson 16-Reliability Improvement.zip](#)

<http://youtu.be/cn-CfDWnUN8>

[G037+G038+G039 Lesson 17-Preparation for emergency.zip](#)

<http://youtu.be/La7Xip8GI2l>

[G037+G038+G039 Lesson 18-Harmonic problems.zip](#)

<http://youtu.be/0Urnkee>

[http://youtu.be/zM\\_Xcwckicw](http://youtu.be/zM_Xcwckicw)

[G037+G038+G039 Lesson 19-Synchronous machine problems.zip](#)

<http://youtu.be/Lx2S-NATr20>

[G037+G038+G039 Lesson 20-Power Generation + Generator Control.zip](#)

<http://youtu.be/56Ks8sArQxc>

[G037+G038+G039 Lesson 21-Turbine Control+ Digital Excitation.zip](#)

<http://youtu.be/uCsvg18qKwQ>

<http://youtu.be/l4vCDI2CZS0>

[G037+G038+G039 Lesson 22-Power System Protection.zip](#)

<http://youtu.be/c6iXRwfCYBU>

[G037+G038+G039 Lesson 23-Switch Gear.zip](#)

<http://youtu.be/DDpbzgNYTiM>

<http://youtu.be/2cl-nOdBNro>



## **Power transformer**

[G040 Lesson 1 Power transformer rating 1.zip](#)

[http://youtu.be/qjWJVQA\\_hjA](http://youtu.be/qjWJVQA_hjA)

[G040 Lesson 1 Power transformer rating 2.zip](#)

<http://youtu.be/JonzO8JD-k4>

[G040 Lesson 2 Open circuit short circuit test.zip](#)

<http://youtu.be/Ru-KIKv40OY>

[G040 Lesson 3 Transformer regulation.zip](#)

<http://youtu.be/t6lZMwMj-B4>

[G040 Lesson 4 Power transformer connection.zip](#)

<http://youtu.be/iig8PISDN1I>

[G040 Lesson 5 Maximum efficiency.zip](#)

<http://youtu.be/Qa7l0eHTWTU>

[G040 Lesson 6 Transformer parallel operation.zip](#)

<http://youtu.be/dkRxoaozrOk>

<http://youtu.be/Sz5QY727w-8>

### [G040 Lesson 7 Harmonic in transformer.zip](#)

[http://youtu.be/\\_YOIWb3e574](http://youtu.be/_YOIWb3e574)

### [G040 Lesson 8 Transformer problem + auto transformer.zip](#)

<http://youtu.be/0KCscbCIUjk>

### [G040 Lesson 9 Transformer rating cooling connection tap changing.zip](#)

<http://youtu.be/d3XHm-wguzQ>

<http://youtu.be/XwilkZnKFqQ>

<http://youtu.be/uOHBk840Bhw>

### [G040 Lesson 10 Phase shift transformer.zip](#)

<http://youtu.be/7aWhg9DloWI>

**G042+IS71**

Page 285 to 307 of [http://www.filefactory.com/file/cf9bf8f/n/Video\\_Lessons.pdf](http://www.filefactory.com/file/cf9bf8f/n/Video_Lessons.pdf)

## [Transmission Line](#)

### [G042 Lesson 1-Transmission line introduction.zip](#)

<http://youtu.be/DrOOgcKeaL4>

### G042 Lesson 2-DC Line+Line reflection.zip

<http://youtu.be/jvVdecp-clk>

### G042 Lesson 3-Power line calculation.zip

<http://youtu.be/3TgVt67DhvY>

<http://youtu.be/QT6agsaM7a0>

<http://youtu.be/WxjQlkdJjQ8>

### G042 Lesson 4-Line model+Economic aspect.zip

[http://youtu.be/1HRdGZXp\\_-w](http://youtu.be/1HRdGZXp_-w)

### G042 Lesson 5-Time value of money+Line reflection.zip

<http://youtu.be/n9mupLQWANY>

<http://youtu.be/YdfiX2gL-3c>

### G042 Lesson 6-Line matching+Wave guide.zip

[http://youtu.be/1Wyp5\\_Cek40](http://youtu.be/1Wyp5_Cek40)

### G042 Lesson 7-Wave guide.zip

<http://youtu.be/BuGtjZ3QBXk>

<http://youtu.be/pftevsnbI0w>

### G042 Lesson 8-Microstrip line.zip

<http://youtu.be/eINq1kKuiec>

### G042 Lesson 9-Per unit value of line.zip

<http://youtu.be/66Y-Lm3EntI>

### G042 Lesson 10-Line constants.zip

<http://youtu.be/2XYnZZ-zXII>

### G042 Lesson 11-Smith chart.zip

<http://youtu.be/dv-NQh4vIrg>

<http://youtu.be/KfM8XZd9Wqc>

<http://youtu.be/3NYVQvW8-Nk>

<http://youtu.be/5qBwLsbtfTA>

[http://youtu.be/ViamcvqAy\\_I](http://youtu.be/ViamcvqAy_I)

[http://youtu.be/j\\_nx9n7mGec](http://youtu.be/j_nx9n7mGec)

<http://youtu.be/d53B3-zV2ec>

[G042 Lesson 12-Four terminals network.zip](#)

<http://youtu.be/HCO4P1qrPbA>

[G042 Lesson 13-Exercises.zip](#)

<http://youtu.be/LeyJf1PhpCY>