



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY

Course Name	:	FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEM
Course Code	:	AEE524
Program	:	B.Tech
Semester	:	VIII
Branch	:	Electrical Engineering
Section	:	A
Academic Year	:	2019 – 2020
Course Faculty	:	Ms.K.Harshini, Assistant Professor

COURSE OBJECTIVES:

The course should enable the students to:	
I	Describe the effect of series and shunt compensation using various FACTS controllers.
II	Static VAR compensator for voltage regulation and transient stability enhancement of system
III	Analyse voltage source converter based FACTS controllers and their coordination.

COURSE OUTCOME(COs):

The course should enable the students to:	
CO1	Understand the fundamentals of FACTS controllers and their role in improving power system performance.
CO2	Understand SVC for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
CO3	Analyse the use of control schemes of TCSC, TSSC, GSC in improving the power quality.
CO4	Analyse the applications of Voltage Source Converter based FACTS Controllers
CO5	Explain the FACTS Controllers and their co-ordination

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
UNIT-I						
1	What is electric power system?	An electric power system is a network of electrical components deployed to supply, transfer, and use electric power.	Remember	CO 1	CLO 1	AEE524.01
2	What is a reliability in power system?	Reliability of a power system is generally designated as a measure of the ability of the system to provide customers with adequate supply	Remember	CO 1	CLO 1	AEE524.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
3	Define FACTS	FACTS is defined by the IEEE as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability"	Remember	CO 1	CLO 1	AEE524.01
4	Define efficiency in System	The efficiency of an entity (a device, component, or system) in electronics and electrical engineering is defined as useful power output divided by the total electrical power consumed	Remember	CO 1	CLO 1	AEE524.01
5	What is the operation of circuit breakers (CB) system?	A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit.	Remember	CO 1	CLO 1	AEE524.01
6	Define Electrical power?	Electric power is the rate, per unit time, at which electrical energy is transferred by an electric circuit. The SI unit of power is the watt, one joule per second.	Remember	CO 1	CLO 3	AEE524.01
7	What is the power flow in transmission line system?	Power Flow through a Transmission Line – So far the transmission line performance equation was presented in the form of voltage and current relationships between sending- and receiving-ends.	Remember	CO 1	CLO 1	AEE524.01
8	Define HVDC transmission?	A high-voltage, direct current (HVDC) electric power transmission system uses direct current for the bulk transmission of electrical power, in contrast with the more common alternating current (AC) systems	Remember	CO 1	CLO 1	AEE524.01
9	What Thyristor Controlled Reactors (TCR)	A Thyristor-controlled reactor (TCR) is a reactance connected in series with a bidirectional thyristor valve. Thyristor-controlled reactors can be used for limiting voltage rises on lightly loaded transmission lines.	Remember	CO 1	CLO 1	AEE524.01
10	What are the disadvantages of low power factor	A Low P.F. draws a higher internal current and the excessive heat generated will damage and/or shorten equipment life. Increased reactive loads can reduce output voltage and damage equipment sensitive to reduced voltage.	Remember	CO 1	CLO 1	AEE524.01
11	Define Power factor?	the power factor of an AC electrical power system is	Remember	CO 1	CLO 3	AEE524.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		defined as the ratio of the real power absorbed by the load to the apparent power				
12	What are the methods for Power factor Improvement?	The events which are favorable to one particular event in any random experiment	Remember	CO 1	CLO 1	AEE524.01
13	Why compensation technique is used in transmission system?	Reactive power (VARs) is required to maintain the voltage to deliver active power (watts) through transmission lines. Also to regulate the power factor of the system and maintain the voltage stability we need to compensate reactive power.	Understand	CO 1	CLO 1	AEE524.01
14	Define SSSC , IPFC and UPFC?	static synchronous series compensator (SSSC), unified power flow controller (UPFC) and interline power flow controller (IPFC).	Remember	CO 1	CLO 2	AEE524.02
15	Operation of TCR and TSR.	TSR and TCR are both composed of the shunt connected reactor, which is controlled by two parallel reverse connected thyristors. TSR is controlled without any firing angle control which results in a step change in reactance. TCR is controlled by firing angle input, which operates in a continuous operation.	Remember	CO 1	CLO 3	AEE524.03
UNIT-II						
1	What is SVC?	A static var compensator (or SVC) is an electrical device for providing fast-acting reactive power on high-voltage electricity transmission networks. SVCs are part of the Flexible AC transmission system device family, regulating voltage and stabilizing the system. The term "static" refers to the fact that the SVC has no moving parts	Remember	CO 2	CLO 4	AEE524.04
2	What are the economic benefits of SVC?	The economic benefits of SVC are 1. Energy savings 2. Increase in productivity 3. Reduction in consumption of electrodes 4. Reduction of heat losses 5. Increase lifetime of furnace inside lining	Remember	CO 2	CLO 4	AEE524.04

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3	What is TSC?	A thyristor switched capacitor (TSC) is a type of equipment used for compensating reactive power in electrical power systems. It consists of a power capacitor connected in series with a bidirectional thyristor valve and, usually, a current limiting reactor	Understand	CO 2	CLO 5	AEE524.05
4	What is transient stability?	The ability of a synchronous power system to return to stable condition and maintain its synchronism following a relatively large disturbance arising from very general situations like switching ON and OFF of circuit elements, or clearing of faults, etc. is referred to as the transient stability in power system	Understand	CO 2	CLO 5	AEE524.05
5	What is Power Oscillation Damping?	With SVC, power oscillation damping (POD) is achieved by dynamic control of the system voltage in such a way that during upward portions of the power vs time profile, the SVC (or SVCs) support(s) the voltage, thereby acting to retard the motion of the rotating machines	Understand	CO 2	CLO 6	AEE524.06
6	What is use of shunt compensation?	It works as a controllable current source. A reactive current is injected into the line to maintain constant voltage magnitude by varying shunt impedance. Therefore, the transmittable active power is increased	Remember	CO 2	CLO 4	AEE524.04
7	What are the methods of shunt compensations?	There are two methods of shunt compensations: 1) Shunt Capacitive Compensation 2) Shunt Inductive Compensation	Remember	CO 2	CLO 4	AEE524.04
8	What are the objectives of series compensation?	The main purpose of series compensation in power systems is to decrease the reactive impedance of the transmission line to reduce voltage drop over long distances and to reduce the Ferranti effect	Remember	CO 2	CLO 5	AEE524.05
9	Define Series Compensation?	Series compensation is the method of improving the system voltage by connecting a capacitor in series with the transmission line. In other words, in series compensation, reactive power is inserted in series with the transmission line	Remember	CO 2	CLO 5	AEE524.05

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		for improving the impedance of the system.				
10	What is FC-TCR?	FC-TCR is a var generator arrangement using a Fixed capacitance with a TCR. θ The current in the reactor is varied by the method of firing delay angle control method. (Qc) of the fixed capacitor is opposed by the (QL) of the TCR.	Remember	CO 2	CLO 5	AEE524.05
11	What is transient free switching?	When the current in an individual capacitor reaches a natural zero-crossing, the thyristors can be left un-biased and no further current will flow. The reactive power supplied to the power system ceases abruptly. This is known as Transient Free Switching.	Remember	CO 2	CLO 6	AEE524.06
12	What is Transient stability?	Transient stability "Transient stability is the ability of the power grid system to maintain synchronism when subjected to severe disturbances."	Remember	CO 2	CLO 6	AEE524.06
13	What is Power Oscillation Damping?	A power oscillation damping controller (PODC) is developed based on swing equations to damp oscillations caused by disturbances in a power system. The input signals of the PODC can be various quantities associated with the tie-line, such as voltage, current, or the power flow on the tie-line.	Remember	CO 2	CLO 6	AEE524.06
14	What is SMIB?	Single Machine Infinite Bus System (SMIB) is a test bus system where one can study the transient response of Synchronous Generator and Effect of Faults on the transmission line	Remember	CO 2	CLO 6	AEE524.06
15	Define SVC?	A static VAR compensator is a set of electrical devices for providing fast-acting reactive power on high-voltage electricity transmission networks. SVCs are used in two main situations: Connected to the power system, to regulate the transmission voltage	Remember	CO 2	CLO 6	AEE524.06
UNIT-III						
1	Define TCSC?	A capacitive reactance compensator which consists of series capacitor banks shunted by a thyristor controlled reactor in order to provide smoothly variable series capacitive reactance.	Understand	CO 3	CLO 7	AEE524.07

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
2	What is thyristor controlled series compensation?	An inductive reactance compensator which consists of a series reactor shunted by a thyristor controlled reactor in order to provide smoothly variable series capacitive reactance.	Remember	CO 3	CLO 7	AEE524.07
3	Differentiate TSSC and TCSC?	TSSC permits discrete control of capacitive reactance and TCSC offers continuous control of capacitive reactance	Remember	CO 3	CLO 8	AEE524.08
4	What is BANG-BANG control IN TCSC?	It is a discrete control in which thyristors are either fully switched on or fully switched off. It's employed to mitigate large disturbance to improve the transient stability.	Remember	CO 3	CLO 09	AEE524.09
5	What is multiple correlations?	The relationship between more than two variables is known as multiple correlation	Remember	CO 3	CLO 8	AEE524.08
6	Compare GCSC and TCSC?	GCSC utilizes a smaller capacitor, does not need any reactor and, differently from the TCSC, does not have an intrinsic internal resonance. For these reasons, the GCSC may be a better solution in most situations where controlled series compensation is required.	Understand	CO 3	CLO 8	AEE524.08
7	What is the firing angle for different modes of TCSC?	Bypassed thyristor mode – conduction angle of 180 degrees Blocked thyristor mode - no firing pulses Vernier mode- varied from minimum value to 180 degrees.	Remember	CO 3	CLO 8	AEE524.08
8	Define Series Compensation?	Series compensation is the method of improving the system voltage by connecting a capacitor in series with the transmission line. In other words, in series compensation, reactive power is inserted in series with the transmission line for improving the impedance of the system.	Understand	CO 3	CLO 7	AEE524.07
9	Define GTO?	A gate turn-off thyristor (GTO) is a special type of thyristor, which is a high-power semiconductor device. It was invented by General Electric. GTOs, as opposed to normal thyristors, are fully controllable switches which can be turned on and off by their third lead, the gate lead.	Remember	CO 3	CLO 8	AEE524.08
10	Why Controlled Series Compensation is used?	Controlled Series Compensation is used in power systems to dynamically control the reactance of a transmission	Remember	CO 3	CLO 8	AEE524.08

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		line in order to provide sufficient load compensation				
11	What is Power system Stability?	Power system stability involves the study of the dynamics of the power system under disturbances. Power system stability implies that its ability to return to normal or stable operation after having been subjected to some form of disturbances	Remember	CO 3	CLO 8	AEE524.08
12	What are the applications of TCSC?	Thyristor controlled series compensator (TCSC) is well-known technical solution which is used in transmission systems on High voltage (HV) and Extra-high voltage (EHV). The main application of TCSC is a power flow control in terms of energy system sustainability	Remember	CO 3	CLO 8	AEE524.08
13	Advantages of Series Compensation	1. Increase in Power Transfer Capability 2. Improvement in System Stability 3. Load Division among Parallel Line	Remember	CO 3	CLO 7	AEE524.07
14	Why power compensation is important in Power System?	The main reason for reactive power compensation in a system is: 1. The voltage regulation 2. Increased system stability 3. Better utilization of machines connected to the system 4. Reduction in losses associated with the system 5. To prevent voltage swell as well as voltage sag.	Remember	CO 3	CLO 9	AEE524.09
15	What is Line Compensation?	Series compensation, reactive power is inserted in series with the transmission line for improving the impedance of the system.	Remember	CO 3	CLO 7	AEE524.07
UNIT-IV						
1	Define Voltage Source Converter?	A voltage source converter is a device which is used to convert DC into AC. It's a converter in which the de voltage always has one polarity and the power reversal takes place through reversal of the current polarity	Remember	CO 4	CLO 10	AEE524.10
2	Define FACTS Controllers?	The FACTS controller is defined as a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters	Remember	CO 4	CLO 1	AEE524.10

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
3	Define Static Synchronous Compensator?	A Static Synchronous Compensator (STATCOM), also known as a static synchronous condenser (STATCON), is a regulating device used on alternating current electricity transmission networks. If connected to a source of power it can also provide active AC power. It is a member of the FACTS family of devices	Remember	CO 4	CLO 10	AEE524.10
4	What is Static Synchronous Series Compensator?	A Static Synchronous Series Compensator (SSSC) is a type of flexible AC transmission system which consists of a solid-state voltage source inverter coupled with a transformer that is connected in series with a transmission line. This feature can provide controllable voltage compensation.	Remember	CO 4	CLO 9	AEE524.11
5	What is Transient Stability?	It is defined as the ability of the power system to return to its normal conditions after a large disturbance. The large disturbance occurs in the system due to the sudden removal of the load, line switching operations; fault occurs in the system, sudden outage of a line	Remember	CO 4	CLO 11	AEE524.11
6	Difference between STATCOM and SSSC?	When a FACTS device (STATCOM or SSSC) is added, the transient energy in post fault period decreases rapidly and that indicates the addition of some damping. With the SSSC, the transient energy decreases at a faster rate than that of the STATCOM and it reaches almost zero value at about 3 s.	Remember	CO 4	CLO 11	AEE524.11
7	Why UPFC is used in power systems	The main advantage of the UPFC is to control the active and reactive power flows in the transmission line. ... The UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system	Remember	CO 4	CLO 12	AEE524.12
8	Why IPFC is used in power systems?	The Interline Power Flow Controller (IPFC) is one of the latest generation Flexible AC Transmission Systems (FACTS) controller used to	Remember	CO 4	CLO 12	AEE524.12

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		control power flows of multiple transmission lines.				
9	Comparison between UPFC and STATCOM?	UPFC injects series voltage in line and follows reference power as required. SVC and STATCOM are simulated in voltage regulation mode where a reference voltage is given at the bus to which they are connected. Their voltage regulation capabilities and reactive power compensation ability is analyzed	Remember	CO 4	CLO 12	AEE524.12
10	Applications of STATCOM?	1. STATCOM is installed to support electrical networks that have a poor power factor and often poor voltage regulation. 2. The most common use of STATCOM is for voltage stability. 3. A STATCOM is a voltage source converter (VSC) based device, with the voltage source behind a reactor.	Remember	CO 4	CLO 12	AEE524.12
11	Applications of SSSC?	1. The SSSC is used for power flow control, voltage stability and phase angle stability. 2. The benefit of the SSSC over the conventional controllable series capacitor is that the SSSC induces both capacitive and inductive series compensating voltages on a line.	Remember	CO 4	CLO 12	AEE524.12
12	How UPF is controlled?	The control of UPFC is done using decoupled control strategy and is found that this enables the device to follow the changes in reference values of active and reactive power	Remember	CO 4	CLO 12	AEE524.12
13	How UPFC Power flow is controlled	The power flow control is done by the UPFC by changing the injected voltage magnitude and phase angle. The performance is analyzed with different power factors and load conditions.	Remember	CO 4	CLO 12	AEE524.12
14	How UPFC Circuit is configured	UPFC Circuit is configured with two voltage source converters, one is shunt converter connected via a shunt transformer and another is series converter connected via a series transformer. The two converters are connected back to back with a common DC link capacitor. This arrangement has three major functions namely series, shunt and phase angle	Remember	CO 4	CLO 12	AEE524.12

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		regulation to be unified in the same circuit				
15	What are the basic modeling of FACTS devices	The basic modeling of FACTS devices can be done in two ways .i)Current Source Converters(CSC) ii)Voltage Source Converters(VSC)	Remember	CO 4	CLO 12	AEE524.12
UNIT-V						
1	What are the different types of FACTS Controllers Interaction	1.Steady-State Interactions 2. Electromechanical-Oscillation Interactions 3. Control or Small-Signal oscillations 4. Sub Synchronous resonance Interactions 5. High-Frequency Interactions	Remember	CO 5	CLO 13	AEE524.13
2	State the various FACTS applications to steady state power system problems	The various FACTS applications to steady state power system problems are 1.FACTS Applications to Optimal Power Flow 2.FACTS Applications to Deregulated Electricity Market	Remember	CO 5	CLO 13	AEE524.13
3	Define the term coordination	In an interconnected or coordinated power system, when the controller parameters of a dynamic device are tuned to obtain the best performance	Remember	CO 5	CLO 13	AEE524.13
4	State the various modes of SVC – SVC Interactions	The various modes of SVC – SVC Interactions are 1.Uncoupled SVC buses 2.Coupled SVC buses	Remember	CO 5	CLO 13	AEE524.13
5	State the various issues arises due to FACTS devices installation	The various issues arises due to FACTS devices installation are 1. Location and Feedback Signals 2. Coordination among Different Control Schemes 3. Performance Comparison	Understand	CO 5	CLO 14	AEE524.14
6	What is small signal oscillations?	Control interaction between individual FACTS controllers and the network or between the FACTS controllers and HVDC links may lead to the onset of oscillations in the range of 2-15 Hz.	Understand	CO 5	CLO 14	AEE524.14

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
7	What is electro-mechanical oscillation interactions	Electro-mechanical oscillation interactions between FACTS controllers involves synchronous generators, compensator machines and associated power system stabilizer controls. The oscillation include local mode oscillation in the range of 0.8-2 Hz and inter area mode oscillations in the range of 0.2-0.8 Hz.	Understand	CO 5	CLO 14	AEE524.14
8	What is the main problem with multiple SVCs in a power system network?	1.Interruption in power supply 2.Unreliability 3.Voltage Instability	Understand	CO 5	CLO 12	AEE524.12
9	What is meant by genetic Algorithm	GA is search procedures based on the mechanics of natural selection and natural genetics. They are develop to allow computers to evolve solutions to difficult problem such as function, optimization and artificial intelligence	Understand	CO 5	CLO 15	AEE524.15
10	What is the roll of Fast control associated with FACTS controllers	Fast control associated with FACTS controllers provide system improvements but they also can interact adversely with one another	Understand	CO 5	CLO 13	AEE524.13
11	What are the analysis methods used to determine the control or Small Signal Oscillation interaction	These high frequency oscillations interactions are dertermined by frequency scanning programs, Electromagnetic Transient Programs(EMTP's), physical simulators and eigen value analysis programs.	Understand	CO 5	CLO 14	AEE524.14
12	What are the frequencies ranges of controllers interactions?	0 Hz for Steady State Interactions 3-3/5 Hz for Electromechanical oscillations 2-15 Hz for small signal oscillations	Understand	CO 5	CLO 14	AEE524.14
13	What are the Combinations of FACTS Controller Interactions	Controller interactions can occur in the following combinations: 1 Multiple FACTS controllers of a similar kind. 2. Multiple FACTS controllers of a dissimilar kind. 3. Multiple FACTS controllers and HVDC converter controllers.	Understand	CO 5	CLO 13	AEE524.13
14	What is Sub Synchronous resonance (SSR) Interactions	Synchronous oscillations may be caused by the interaction between the generator torsional system and the series-compensated-transmission lines, the HVDC converter controls,	Understand	CO 5	CLO 13	AEE524.13

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		the generator excitation controls, or even the SVCs. These oscillations, usually in the frequency range of 10–50/ 60 Hz, can potentially damage generator shafts.				
15	What is range of High – Frequency Interactions	High-frequency oscillations in excess of 15 Hz are caused by large nonlinear disturbances, such as the switching of capacitors, reactors, or transformers, for which reason they are classified as electromagnetic transients.	Understand	CO 5	CLO 14	AEE524.14

Signature of the Faculty

HOD, EEE

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