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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

MAKEUP EXAMINATION – JULY 2024

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| **Semester :** 6th | **Date :**1/07/2024 |
| **Course Code :**EEE3021 | **Time :**1:30 pm to 4:30 pm |
| **Course Name :**Flexible AC Transmission system(FACTS) | **Max Marks :**100 |
| **Program :** B.Tech & 6th Sem | **Weightage :**50% |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

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| **PART A** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 2M=10M** | | | |
| 1 | When it comes to power systems, what exactly are the goals of regulators for static voltage and phase angle? | (CO1) | [Knowledge] |
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| 2 | When it comes to the Unified Power Flow Controller (UPFC), what exactly are its goals and requirements? | (CO1) | [Knowledge] |
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| 3 | H How does the Unified Power Flow Controller (UPFC) function according to its basic operating principle? | (CO1) | [Knowledge] |
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| 4 | State the term "NGHSSR damper". | (CO1) | [Knowledge] |
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| 5 | State the role of STATCOM in the operation of power systems?. | (CO2) | [Knowledge] |
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| 6 | Summarize about the variable impedance type series compensators such as GCSC, TSSC, and TCSC? | (CO2) | [Knowledge] |
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| 7 | Explain how shunt compensators of the variable impedance type help to the improved performance and stability of power systems. | (CO3) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | To regulate voltage and power flow in a transmission line, the most flexible FACTS controller is Gyugyi's suggested Unified Power Flow Controller (UPFC).There are two VSCs in total, one of which is connected in series while the other is shunt. Both converters' DC capacitors are connected in parallel. If both switches 1 and 2 are open, the two converters function as a STATCOM and SSSC, respectively, to regulate the shunt and series reactive current and voltage delivered into the line. During short circuit problems on a parallel transmission line, the UPFC can help in a number of ways, which you should summarise. | (CO2) | [Understand] |
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| 9 | Power transmission efficiency along EHV transmission lines over great distances has been enhanced through the use of capacitors connected in series.Improving power distribution at the lowest possible cost can be achieved by increasing the number of capacitors linked in series. System planners have been hesitant to fully commit to series compensation, however, due to the SSR issue.Although shunt capacitors' efficacy is significantly location-dependent, there is no need to worry about SSR when employing them. Using series capacitors in long lines is appealing because thyristor control can provide variable series compensation. The SSR issue, also known as the torsional interaction, has been much mitigated, which is a big plus. Use the given information to explain how you would go about modelling a series compensator using continuous control. | (CO3) | [Understand] |
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| 10 | A STATCOM is able to regulate the voltage on the bus to which it is connected and function as a voltage regulator because it supplies reactive power in the same way that a synchronous condenser (or compensator) does. This allows the STATCOM to change the voltage. When comparing SC and STATCOM, it is essential to keep in mind that the AC voltage at the output of the former is produced by the synchronous functioning of the switches, whereas the AC voltage at the output of the latter is produced by magnetic induction as a result of the rotation of the DC field winding on the rotor. This is an important distinction to make because the synchronous functioning of the switches is responsible for producing the AC voltage at the output of the former. These two processes, when combined, result in the generation of an alternating current at the output of their respective devices. This voltage, in contrast to the voltage that is output by a SC, contains a considerable amount of harmonics that need to be dealt with in some manner. After carrying out some investigation, explain the many methods in which T1, T2, D1, and D2 function, as well as the specific uses for each of these. | (CO4) | [Understand]] |
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| 11 | Quickly regulating and controlling dynamic (temporary) overvoltages caused by load throw off, faults, or other transient disturbances is where SVC really shines. In addition to preventing voltage instability (collapse) caused by unforeseen events, dynamic reactive control at the load bus improves power transfer. Remember that in a steady state, voltage can be controlled by mechanically switched capacitors and reactors (MSC and MSR). Fast voltage regulation, however, is necessary to prevent instability during brief events. Create a block diagram explaining the thought process behind the SVC controller's layout while discussing its implementation. | (CO4) | [Understand] |
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| 12 | Modern power systems are built to reliably supply power on demand to a variety of load centres. Power must be sent from the generators to the load centres via a network of transmission lines running at high or extremely high voltages. For practical and financial reasons, today's power grids are increasingly interconnected, and not just through the transmission lines that deliver energy from generators to consumers. Since the power at either end of an AC line is what controls the direction of the current, AC lines feature built-in power flow control. Assuming the line is lossless and disregarding any line losses, Provide accompanying equations to discuss the power flow between the sending and receiving ends and how FACTS controllers can be utilised to enhance the power flow. | (CO4) | [Understand] |
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| 13 | The major application of SVC is for rapid voltage regulation and control of dynamic (temporary) overvoltages caused by load throw off, faults or other transient disturbances. The dynamic reactive control at the load bus increases power transfer and can solve the problem of voltage instability (collapse) caused by contingency conditions. It is to be noted that steady state voltage regulation can be achieved by mechanically switched capacitors and reactors (MSC and MSR). However, fast voltage regulation is required to prevent instability under transient conditions. By referring to the above statememts, Discuss about the controller design of SVC by drawing the block diagram of the controller. | (CO4) | [Understand] |
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| 14 | A STATCOM is comparable to a Synchronous Condenser (or Compensator) which can supply variable reactive power and regulate the voltage of the bus where it is connected. The equivalent circuit of a Synchronous Condenser (SC) shows a variable AC voltage source (E) whose magnitude is controlled by adjusting the field current. Neglecting losses, the phase angle (δ) difference between the generated voltage (E) and the bus voltage (V ) can be assumed to be zero. By varying the magnitude of E, the reactive current supplied by SC can be varied. When E = V , the reactive current output is zero. When E > V , the SC acts as a capacitor whereas when E < V , the SC acts as an inductor. The voltage and current waveforms of a 3 phase STATCOM has been provided in the figure below which has been used in a substation for Shunt Compensation. Explain the opeartion of the STATCOM in brief after Identifying whether its a 6 pulse or 12 pulse STATCOM. | (CO3) | [Understand] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 14 | Series Capacitors have been used in long distance EHV transmission lines for increasing power transfer.The use of series capacitors is generally the most economic solution for enhancing power flow. However, the problem of SSR has deterred system planners from going in a big way for series compensation.While the use of shunt capacitors don’t have the problem of SSR, they have drawbacks of their effectiveness being dependent largely on their location. The use of thyristor control to provide variable series compensation makes it attractive to employ series capacitors in long lines. A major advantage is that the SSR problem (Torsional Interaction) is significantly reduced. Referring to the above statements, Explain the Modelling of a Series compensator with continuos control with the help of supporting equations | (CO2) | [Apply] |
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| 15 | For stability studies it is not necessary to model the gate pulse unit and the generation of gate pulses. It is adequate to assume that the desired value of TCSC reactance is implemented within a well defined time frame. The value of TT CSC is from 15 to 20 ms. Xref is determined by the power scheduling controller or in its absence, by manual control based on order from load dispatch.Explain the block diagram of TCSC Controller after drawing in brief. | (CO2) | [Apply] |
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| 16 | The question of subsynchronous resonance will arise in all FACTS applications, for brief or for in-depth consideration, for the basic reason that all high-speed, high power Controllers have potential of enhancing or degrading subsynchronous phenomenon. This not only applies to the FACTS Controllers, but also HVDC, the Automatic Voltage Regulator (AVR), Power System Stabilizer, etc. The subsynchronous problem is aggravated by series capacitor compensation and also high-speed reclosing of faulted lines with or without series capacitor compensation. It is therefore important for any power systems engineer to be familiar with this phenomenon, particularly those involved with the FACTS technology, because almost every FACTS Controller offers an opportunity for a SSR-neutral design and for value-added benefit in this area. Electric power generation involves interaction between the electrical and mechanical energies coupled through the generators. It follows that any change in the electric powersystem results in a corresponding reaction/response from the mechanical systems and vice versa. Slow-changing load translates into slow-changing mechanical torque on the rotor shafts, which in turn is matched by slow-changing rotor angles to new steady-state angles between the rotors and the stators along with adjustment in the mechanical power input to the rotors through the turbines. Major disturbances such as faults and fault clearing, etc. result in high-transient torques on the mechanical system and corresponding transient twisting of the rotor shaft couplings between tandem turbines and generators. By referring to the above statements, explain the functions of TCBR | (CO3) | [Apply] |