Subject Name:PSOC

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Year and Sem, Department:IV-EEE SEM-II

Unit-I
LOAD FREQUENCY CONTROL

Important points / Definitions:

Load frequency control

1. Sense the bus bar frequency &power frequency
2. Difference fed to the integrator & to speed changer
3. Tie line frequency maintained constant

Economic dispatch control

1. When load distribution between a number of generator units considered optimum schedule affected when increase at one replaces a decreases at other.
2. Optimum use of generators at each station at various load is known as economic dispatch control.

Automatic voltage regulator

1. Regulate generator voltage and output power
2. Terminal voltage & reactive power is also met

System voltage control

Control the voltage within the tolerable limits. Devices used are

1. Static VAR compensator
2. Synchronous condenser
3. Tap changing transformer
4. Switches
5. Capacitor
6. Reactor

Security control

1. Monitoring & decision
2. Control

Monitoring & decision:

1. Condition of the system continuously observed in the control centers by relays.
2. If any continuous severe problem occurs system is in abnormal condition.

Governor Controlled Valves:

They control the input to the turbine and are actuated by the speed control mechanism.

Speed Control Mechanism:

It includes all equipment such as levers and linkages,servomotors, amplifying devices and relays that are placed between the speed governor and the governor controlled valves.

Speed Changer:

It enables the speed governor system to adjust the speed of the generator unit while in operation.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. draw the speed-load characteristics
2. discuss in detail state variable model
3. explain the two area system model diagram
4. what is need of speed governing system
5. what is meant by tie line bias control
6. **Describe in detail off load and on load tap changing transformers.**
7. **Explain D.C and A.C excitation system**
8. **Write the transfer function of an overall excitation system.**
9. **Represent a model of speed governing system i by a block diagram.**
10. **Write short notes on compensated and un-compensated transmission lines.**

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.a) Mention some of the advantages of interconnection of areas.
b) Why Proportional plus Integral control of single area is required?
c) What do you understand by economic dispatch control?
d) What will be steady state frequency error of a controlled isolated power system?

2. Two generators rated 300 MW and 400 MW respectively are operating in parallel. The droop characteristics of their governors are 4% and 6% respectively from no load to full load. The speed changers of the governors are set so that a load of 400 MW is shared among the generators at 50 HZ in the ratio of their ratings. What are the no load frequencies of the generators

3.a) Obtain the mathematical modeling of speed governing system.

b). Obtain the transfer function and block diagram representation of First order turbine model

4.a)Derive the expression for analysis of integral control for steady state response.
b) With a first order approximation, explain the dynamic response of an isolated area for load frequency control

5.a) With a neat block diagram explain the load frequency control for a single area system.
b) The two area system has the following data:
Capacity of area 1, Pr1 =1000 MW,
Capacity of area 2, Pr2 =2000 MW,
Nominal load of area 1, PD1=500 MW
Nominal load of area 1, PD1=1500 MW
Speed regulation of area 1=4%
Speed regulation of area 2=3%
Find the new steady state frequency and change in the line for a load change of area 2 by 125 MW. For both the areas each percent change in frequency causes 1 percent change in load. Find also the amount of additional frequency drop if the interconnection is lost due to certain reasons.

6. a) What are the different components of speed governor mechanism?
b) Write the transfer function of turbine model and represent in a block diagram.
c) What are the assumptions made in dynamic response of uncontrolled case in single area load frequency control?
d) What is meant by tie-line bias control?

7.a)Derive transfer function of speed governor and represent its block diagram.

b). what is an excitation system? What are its characteristics? Derive its transfer function and represent block diagram.

8.a) Show that the steady change in frequency in load frequency control of an isolated power can be reduced to zero if the change in controlling force applied to the speed changer is equal to the change in load demand.
b) Distinguish between load frequency control and economic dispatch control.

9.a) Draw the block diagram of load frequency control in two area control system and explain.
b) Determine the primary ALFC loop parameters for a control area with the following data: Total generation capacity = 2500 MW; Normal operating load =1500 MW; Inertia constant=5 kW-seconds per kVA; Load damping constant, B=1 %; Frequency, f=50 Hz; and Speed regulation, R=2.5 Hz / p.u MW.

10.a) What are the important methods of hydro-thermal coordination?
b) Draw the block diagram representation of steam turbine.
c) What is the need of excitation system?
d) What is the need of integral control in single area LFC System?
e) What is meant by area control error in two area system?

Fill in the Blanks: (Minimum 10 to 15 with Answers)

1. Fly ball speed governor is the ________heart______ of the turbine speed governing system.

2. As the speed increases the fly balls moves __outwards_________.

3. If the pilot valve moves upwards then ___low______ pressure steam is moved into the hydraulic amplifier.

4. ________**Speed changer**________ provides the steady state power output for the turbine in a speed governing system .

5. The expression for speed regulation of a governor is given by ____**K1/K**_________.

6. 1/K4.K5 is the **Time constant** of speed governor.

7. The transfer function of a turbine model is written as **Kt/(1+S.Tt)**.

8. In a generator load model ,the expression for time constant is given by **2H/Bf**.

9. 1/B represents **Inertia** of the power sytem.

10. AVR stands for **Automatic voltage regulator**

Key:

1. Heart 2. outwards 3. High 4. Speed changer 5. K1/K 6. Time constant

7. Kt/(1+S.Tt) 8. 2H/Bf 9. gain 10. Inertia 11. Automatic voltage regulator

12. d 13. C 15. A 16. A 17. A 18. C 19. D 20.A

Choose the Best:

1. The main economic factor in power system operation is [D]

   (a) The cost of reactive power compensation (b) The cost of power generation

   (c) The cost of operation and Maintenance (d) The cost of power transmission

2. The optimum allocation of generation at each generating station is called [C]

   (a) Unit commitment (b) load scheduling

   (c) load dispatching (d) load consuming

3. The slop of the cost curve is [A]

   (a) dC_i/dP_G (b) dP_G/dC_I (c) dc_I/dt (d)dP_G/dt

4. The unit for Incremental cost is [A]

   (a) Rs per Mwh (b) Rs per Mw (c) Rs per hour (d) Rs

5. Area frequency response characteristic is [A]

   (a) D+1/R (b) R+1/D (c) D/R (d) -D/R

6. Line compensation [C]

   (a) increases ferrranti effect (b)requires under excited operation of generators

   (c)reduces power transfer capability (d)is never used in power operation

7. When fault occurs near the synchronous condenser, it will result in _______ of short circuit currents. [D]

   (a) Decrease (b) fluctuation (c) increase (d) a or c

8. Under over excitation, the power factor of the motor is [A]

   (a) Leading (b) lagging (c) unity (d) zero

9. nomally the time constant of a speed governor is less than _______ ms. [D]

   (a) 1000 (b) 10 (c) 100 (d) 0.1

10. Units for speed regulation of governor is [C]

(a) HZ (b) HZ per MVA (c) HZ per MW (d) no12.

UNIT-2

REACTIVE POWER- VOLTAGE CONTROL

Important points / Definitions:

GENERATION AND ABSORPTION OF REACTIVE POWER

Synchronous Generators:

Synchronous machines can be made to generate or absorb reactive power depending upon the excitation (a form of generator control) applied. The ability to supply reactive power is determined by the short circuit ratio.

Synchronous Compensators:

Certain smaller generators, once run up to speed and synchronized to the system, can be declutched from their turbine and provide reactive power without producing real power.

Capacitive and Inductive Compensators:

These are devices that can be connected to the system to adjust voltage levels .A capacitive compensator produces an electric field thereby generating reactive power An inductive compensator produces a magnetic field to absorb reactive power. Compensation devices are available as either capacitive or inductive alone or as a hybrid to provide both generation and absorption of reactive power.

1. Overhead lines and underground cables, when operating at the normal system voltage, both produce strong electric fields and so generate reactive power.

2. When current flows through a line or cable it produces a magnetic field which absorbs reactive power.

3. A lightly loaded overhead line is a net generator of reactive power while a heavily loaded line is a net absorber of reactive power.

4. In the case of cables designed for use at 275 or 400kV the reactive power generated by the electric field is always greater than the reactive power absorbed by the magnetic field and so cables are always net generators of reactive power.

5. Transformers always absorb reactive power.

4.METHODS OF VOLTAGE CONTROL

Reactors:

Inductive reactors absorb reactive power and may be used in circuits, series or shunt connected, while series connected reactors are used to limit fault currents, shunt reactors are used for var control

SHORT QUESTIONS

1. Explain the shunt compensation R09- march-2017
2. Dicuss the series compensation R13-(Nov/dec-2016)
3. What is need of tap changing off load transformer? ? R09- nov/dec-2015
4. What is need of line compensation? ? R09- nov/dec-2015
5. What is need of reactive power control of power system?
6. Distinquish between line and load compensation.? R09- march-2017
7. What are the specifications of load compensator? R13-(Nov/dec-2016)
8. What does on mean by load compensation? R09- nov/dec-2015
9. With neat diagrams discuss series compensation? R09- nov/dec-2016
10. State the difeerent types of reactive power compensating equipments for Tr.Systems?

Long Questions

1. a) Explain D.C excitation system and A.C excitation system

b) List out the advantages of Static VAR compensator

2.a) Explain clearly what you mean by compensation of line and discuss briefly different methods of compensation.

b) With a neat sketch, explain how a STATCOM works.

3.a) Name the reasons for variation of voltages in power systems and explain any one method to improve voltage profile.

b) A 440V, 3-Ø distribution feeder has a load of 100 KW at lagging p.f. with the load current of 200A. If the p.f. is to be improved, determine the following:

i) Uncorrected p.f. and reactive load

ii) New corrected p.f. after installing a shunt capacitor of 75 KVAR.

4.a) What is the need of reactive power control in a power system?

b) What is meant by load compensation?

c) Explain the generation and absorption of reactive power

5. a) Explain briefly about the shunt and series compensation of transmission systems.
b) A short transmission line having an impedance of (2+j3) ohms interconnects two power stations A and B both operating at 11 kV; equal in magnitude and phase. To transfer 25 MW at 0.8 p.f. lagging from A to B determine the voltage boost required at plant A.

6. a) Write short notes on compensated and uncompensated transmission lines.
b) A three-phase Induction motor delivers 500 hp at an efficiency of 0.91, the operating power factor being 0.76 lagging. A loaded synchronous motor with a power consumption of 100 KW is connected in parallel with the induction motor. Calculate the necessary kVA and the operating power factor of the synchronous motor if the overall power factor is to be unity.

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7 .a) explain the tap setting OLTC Transformer
b) Transmission line compensation

8.a) Compare the different types of compensating equipment for transmission system?
b) Explain the uncompensated and compensated transmission lines.

9.a) What are the merits and demerits of shunt and series compensation?
b) Describe the reactive power compensation in transmission systems

10. a) explain the tap -changing the transformer
b) Explain the Excitation system –modeling

Fill in the blanks:

1. Static VAR compensators **Improve** the power factor.
2. **Series-capacitor** compensation produces undamped oscillations.
3. **Static VAR** compensators reduce voltage swings at rolling mills.
4. An in-phase voltage booster would control **Reactive** power flow in the system.
5. The natural loading limit is the **Lowest** limit for power transfer.
6. The quadrature voltage compensator would control **Active** power flow in the system.
7. **Thermal** limit is the highest limit for power transfer.
8. Cables are the generators of active power.
9. **VAR** machines can be used in a power system network for the control of reactive power .
10. Transmission lines absorb reactive power when they are **Synchronous** loaded and generate active power when they are actually loaded.

Choose the Best:

1. Line compensation [D]

(i) increases ferrranti effect (ii)requires under excited operation of generators

(iii)reduces power transfer capability (iv)is never used in power operation

(a) (i) & (ii) are false (b) (ii) & (iii) are false

(c) (i),(iii) & (iv) are false (d) all are false

2. In VAR compensators using thyristors, filters are needed for **5th and 7th** harmonic.

3. For a 400KV line, the ratio X/R is about [D]

(a) 1.5 (b) 6 (c) 10 (d) 16

4. Transformers always absorb ________ power. [b]

(a) Active (b) reactive (c) apparent (d) both a and b

5. During peak load conditions ,the transmission line needs **Reactive** VARS at the receiving end.

(a) Leading (b) lagging (c) unity (d) zero [b]

6. Under over excitation, the power factor of the motor is [C]

(a) Leading (b) lagging (c) unity (d) zero

7. When fault occurs near the synchronous condenser, it will result in _______ of short circuit currents.

(a) Decrease (b) fluctuation (c) increase (d) a or c [A]

8. For slack bus the penalty factor is [D]

(a) unity (b) zero (c) infinity (d) none

9. Incremental transmission loss of a grid will be [C]

(a) unity (b) zero (c) infinity (d) none

10. The penalty factor is always [B]

(a) less than 1 (b) more than 1 (c) a or b (d) equal to 1

UNIT-3
ECONOMIC LOAD DISPATCH

Important points / Definitions:

Economic Operation of Power Systems

One of the earliest applications of on-line centralized control was to provide a central facility, to operate economically, several generating plants supplying the loads of the system.

The operation economics can again be subdivided into two parts.

i) Problem of *economic dispatch*, which deals with determining the power output of each plant to meet the specified load, such that the overall fuel cost is minimized.

ii) Problem of *optimal power flow*, which deals with minimum – loss delivery, where in the power flow, is optimized to minimize losses in the system. In this chapter we consider the problem of economic dispatch.

- During operation of the plant, a generator may be in one of the following states:

i) Base supply without regulation: the output is a constant.

ii) Base supply with regulation: output power is regulated based on system load.

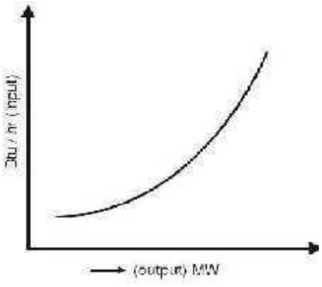
iii) Automatic non-economic regulation: output level changes around a base setting as area control error changes.

iv) Automatic economic regulation: output level is adjusted, with the area load and area control error, while tracking an economic setting.

Performance Curves:

Input-Output Curve

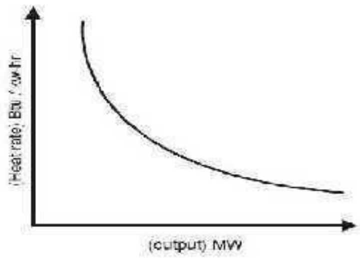
This is the fundames a plot of the input in British Thermal units (Btu) per ho nt in MW as shown in Fig 2.1



Input – output curve

Heat Rate Curve

The heat rate is the ratio of fuel input in Btu to energy output in KWh. It is the slope of the input – output curve at any point. The reciprocal of heat – rate is called fuel –efficiency. The heat rate curve is a plot of heat rate versus output in MW.

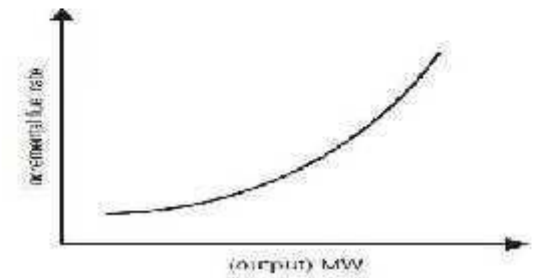


Heat rate curve.

Incremental Fuel Rate Curve

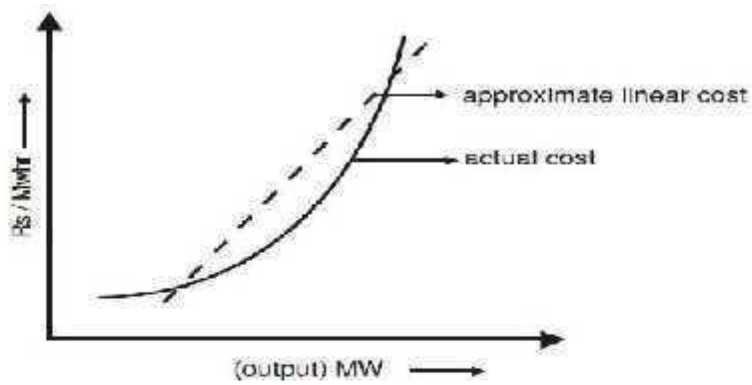
The incremental fuel rate is equal to a small change in input divided by the corresponding change in output.

Incremental fuel rate $=\Delta Input/\Delta\ Output$



INCREMENTAL COST

The incremental cost is the product of incremental fuel rate and fuel cost (Rs / Btu or $ /Btu). The curve in shown in Fig. 4. The unit of the incremental fuel cost is Rs / MWh or $ /MWh.



Incremental cost curve

In general, the fuel cost Fi for a plant, is approximated as a quadratic function of the generated output PGi.

$$F_i = a_i + b_i P_{Gi} + c_i P_G^2 \text{ Rs / h} \quad (4)$$

Solution Methods:

1. Lagrange Multiplier method
2. Lamda iteration method
3. Gradient method
4. Dynamic programming
5. Evolutionary Computation techniques

SHORT QUESTIONS

1. Drive equation of penalty factor-(Nov/dec-2016)
2. Derive equation of incremental transmission losses
3. Draw the curve of heat rate curve-(Nov/dec-2016)
4. What are co-ordination equations?
5. Define the incremental fuel and production cost -(Nov/dec-2016)

6. Explain about heat rate curve? R09- march-2017
7. What is the penalty factor in economic scheduling? R13-(Nov/dec-2016)
8. Write the generalized expression for transmission loss in a n-bus network? R09- nov/dec-2015
9. Explain the following terms w.r.t thermal power plants? (i). incremental fuel rate curve (ii) input output curve R09- nov/dec-2014
10. what are coordination equations? Give their physical significance? R09- nov/dec-2014,

Long Questions

1.a) Draw the input-output characteristics of a Thermal plant.
b) What is an Incremental fuel Cost
c) heat rate curve
d) Incremental production cost curve

2.a) Give various advantages of general loss formula and state the assumptions made for calculating Bmn coefficients.
b) In a thermal power station, incremental costs are given by the following equations:
$dc1/dp1 = Rs. (0.15P1 + 12)$;
$dc3/dp3 = Rs. (0.21P3 + 13)$;
$dc2/dp2 = Rs. (0.05P2 + 14)$.
Where P1, P2 and P3 are the loads in MW. Determine the economical load allocation between the three units, when the total load on the station is 300 MW.
3.a)Define incremental fuel cost and production cost.
b) What is a penalty factor? What is its importance in optimal operation of generators in thermal power stations?
4.a) Derive an expression for economic distribution of load between generating units including the effect of transmission losses.
b) The fuel cost in Rs/h for a three thermal plants are given by
F1=350+7.2PG1+0.004PG1 2 ,F2=500+7.3PG2+0.0025PG2 2,F3=600+6.74PG3+0.003PG3 2 PG1, PG2, PG3 are in MW. Find the optimal schedule and compare the cost of this to the case when the generators share the load equally if i) PD=450 MW ii) PD=800 MW.
5. a) What is a penalty factor in economic scheduling?
b) Define the incremental fuel and production costs.

6.a) Explain the need of economical load dispatch for a given power system.
b) A system consisting of two plants connected by a tie line and load is located at plant-2. When 100MW is transmitted from plant-1, a loss of 10MW takes place on the tie line. Determine the generation schedule at both the plants and the power received by load when λ of the system is 25Rs/MWh and IFC are given by
dc1/dp1= 0.03P1+17 Rs/MWh, dc2/dp2 = 0.06P2+19 Rs/MWh.

7.a)how is generation scheduled among various generators when transmission losses are neglected in a thermal system ?explain.
b) Develop an algorithm and draw the flow chart the solution of coordination equations.

8. Derive the transmission loss formula for a system consisting of n-generating plants supplying several loads inter connected through a transmission networks. State any assumptions are made.

Fill in the blanks:

1. Expression for transmission loss formula was given by __**dopezo-etal**__________.
2. In the derivation of transmission loss formula __**tensors**________ transformation was used.
3. If a generating unit is situated near to the load center the penalty factor for that unit is_LESS_____.
4. Loss coefficients are also called as __**B-coefficients**
5. B_{mn} coefficients is an __**constant**______________ matrix.
6. In deriving loss formula coefficients the ratio of real to reactive power is
7. Units for B_{mn} coefficients is __**$(MW)^{-1}$**______________.
8. General transmission loss formula is used for exact calculation of **transmission losses**
9. **Bmn-cofficients** are used in power system designing.
10. The incremental transmission loss of a plant is_**Positive**.

Choose the Best:

1.The main economic factor in power system operation is [B]

(a) The cost of reactive power compensation (b) The cost of power generation

(c) The cost of operation and Maintenance (d) The cost of power transmission

2. The optimum allocation of generation at each generating station is called [A]

(a) Unit commitment (b) load scheduling

(c) load dispatching (d) load consuming

3. The optimum allocation of generation to each station for various system load level is called

(a) load dispatching (b) load scheduling [B]

(c) unit commitment (d) power generating

4. The major component of generator operating cost is [A]

(a) The fuel I/P hour (b) The maintains cost

(c) The operating cost of supporting Equipment (d)None

5. The fuel cost of meaningful only is case of [D]

(a) Hydro station (b)Diesel station

(c) Thermal station (d) Thermal and Nuclear stations

6. The slop of the cost curve is [A]

(a) dC_i/dP_G (b) dP_G/dC_I (c) dc_I/dt (d)dP_G/dt

7. The Optional loading of generator corresponding to the Equal Incremental cost point of all the generators equation is called [B]

(a) The differential Equation (b) The co-ordination Equation

(c) The algebraic Equation (d) The quadric Equation

8. To determine the units of a plant that should operate for a particular load is the problem of

(a) The load scheduling (b) The unit commitment [B]

(c) The dynamic programming (d) Both a and b

9. The unit of lagrangian multiplier _ is [A]

(a) Rs/MW hr (b) Rs/MW/hr (c) MWhr/Rs (d) Whr/Rs

10. The unit for Incremental cost is [C]

(a) Rs per Mwh (b) Rs per Mw (c) Rs per hour (d) Rs