Chettinad College of Engineering & Technology
Approved by AICTE-New Delhi and Affiliated to Anna University-Chennai

Academic Year 2024 – 2025

Question Bank

Year/Semester: III/ VI **Date:17/02/2025**	**Department:Electrical and Electronics Engineering** **Subject Code/Title: EE3602-PowerSystemOperation&Control** **Faculty Name:P.Thenmozhi**	**Unit :** I/II/III/IV/V **Section : Part A/B/C**

UNIT-I
INTRODUCTION
PART– A

1. List out the requirements of a good power system. N-D 2022, (Nov-Dec 2021)

Planning the operation of a power system requires load studies, fault calculations, the design ofmeansforprotectingthesystemagainstlightningandswitchingsurgesandagainstshortcircuitsandst udies of the stability of the system. Steps to be followed.

- Planning of power system.
- Implementation of the plans.
- Monitoring of the system.

2. Define Plant capacity factor.N-D2013

Thisistheratioofactualenergyproducedtothemaximumpossibleenergythatcouldhavebeenproduced duringagiven period.

$$\text{Capacityfactor} = \frac{\text{Actualenergyproduced}}{\text{Maximumenergythathavebeenproduced}}$$

3. List out the various needs for frequency regulation in power system. N-D 2021, N-D2016,2013

Thespeed of thesystemis directlyproportional tothefrequencyof thesystem.

$$N\alpha f$$

Wheneverthereischangeinthespeedofthesystem,frequencyofthesystemalsovaries.Inordertomaintainthe frequencyof thesystem in aconstantlevel wehaveto undergo frequencyregulation.

a. Inanypowersystem,ifthefrequencychangestherewon‟tberequiredreceivingendvoltage.Ifwecon necttwo systems in parallel, it will spoil thesystem.

b. Thegeneratorturbines,particularlysteamdrivenonesaredesignedtooperateataveryprecisespeed.

c. Mostof ACmotors runsat speedsthat aredirectlyrelated tothefrequency

Whentwosystemsworkingatdifferentfrequenciesaretobetiedtogethertomakesamefrequency,frequencyconvertingstations or links arerequired.

4. State maximum demand. M-J2014

Maximum demand is the greatest demand of load on the power station during a given period. Thegreatest of all “short time interval averaged” during a given period on the power station is called themaximum demand.

5. Define Plant use factor.M-J2014

Plant use factories defined as the ratio of the actual energy generated during a given period to theproduct of plant capacity and the number of hours for which the plant was in operation during the period oftime.

$$\textbf{Plantusefactor} = \frac{\textbf{TotalkWhgenerated}}{\textbf{RatedcapacityoftheplantxNumberofoperatinghours}}$$

6. Distinguish between load curve and load duration curve.N-D2014

Load factor	Diversity factor
❖ Load factor is defined as the ratio of Average load to the maximum demand During a certain period of time. ❖ Theaverageloadislessthanthe maximumdemand;loadfactoristherefore,always lessthanunity.	❖ Maximum demand on the installation is, Therefore always less than the sum of Individual maximum demands of all consumers connected to it. ❖ Thevalueofdiversityfactorwillbe always greaterthanunity.

7. Define the term Diversity factor. N-D2014

The maximum demand of all the consumers supplied from aninstallation do not occurusually at the same time, maximum demand on the installation is, therefore always less than the sum ofindividualmaximum demands ofall consumers connected toit.

Theratioofthesumofindividualmaximumdemandofalltheconsumerssuppliedbyittothemaximumdemand ofthe power station is knownas diversityfactor.

Diversityfactor= $\frac{\textbf{Sumofindividualmaximumdemand}}{\textbf{Maximumdemand}}$

Thevalueofdiversityfactorwillbealwaysgreaterthanunity.

8. List the significance of load factor. N-D 2022,N-D2015

Significanceof LoadFactorarelistedasfollows

- Loadfactorisalwaysgreaterthanunity,becauseaverageloadissmallerthanmaximumdemand.
- Itisused todeterminetheoverallcost perunitgenerated.
- If theloadfactor ishigh,costperunitgeneratedislow.

9. Define demand factor.N-D2015

Demandfactoristheratioofactualmaximumdemandonthesystemtothetotalratedloadconnected to the system. It is always less than the unity; the demand factor decides the maximum constraintsonpower system operation based on load.

Demandfactor= $\frac{\textbf{Maximumdemand}}{\textbf{Connectedload}}$

Clearly,theideaofdemandfactorwasintroducedduetothefactthatalltheequipmentconnectedtothe System will not beworkedatatimeinpracticeandthekWorkVAmaximumdemandofagroupofelectricityconsumingdevices will always belessthan thecapacities ofthe devices.

10. Classify thesystemload. M-J 2016

Theloadonapowersystemvariesfromtimetotimeduetouncertaindemandsoftheconsumers,known as variableload on the station.

Thesystemloadinanarea dependsonresidentialcommercial,industrial, agricultural,municipalandtractionloads.Systemload variationoccursduetospecialevents onreligiousand socialoccasions,etc.

Typesofload arelisted asfollows:

- Lightingload
- Heatingloads.
- Inductionmotors.
- Electronicdevices.

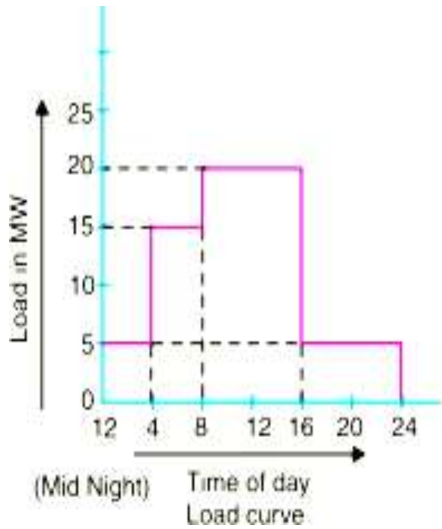
11. Define spinning reserve.N-D2018M-J2016

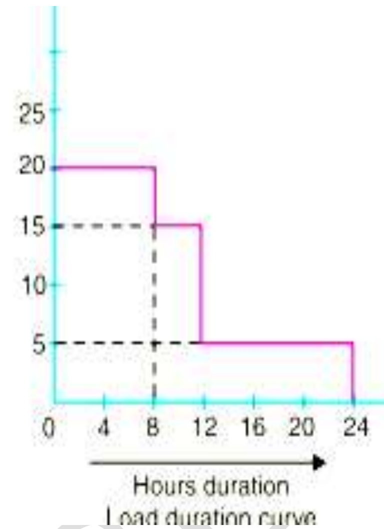
Spinningreserveis thatgeneratingcapacitywhichis connected to the bus and is ready to take load.

12. Define Load Duration Curve.N-D2016

This type of curve which indicates the variation of load, but with the loads arranged in descending order of magnitude, i.e., thegreatestload on the leftand lesserloadstowards right.

From this curve, the load





13. State the need of load forecasting.N-D2018,A-M2017,2015

- Tomeet out the futuredemand.
- Longtermforecastingisrequiredforpreparingmaintenancescheduleofthegeneratingunits,planningfutureexpansion of thesystem.
- Forday-to-day operation,short term loadforecastingisneededinordertocommitenoughgeneratingcapacityfor the forecasting demand and for maintaining the required spinning reserve.
- Very short term load forecasting is used for generation and distribution. That is, economic generationschedulingand load dispatching.
- Mediumtermloadforecastingisneededforpredictedmonsoonactingandhydroavailabilityandallocating.

14. Define Black out&brownouts.A-M2017

A brownout is an intentional or unintentional drop in voltage in an electrical power supply system.Intentional brownouts are used for load reduction in an emergency. The reduction lasts for minutes or hours,as opposed to short-term voltage sag (or dip). The term brownout comes from the dimming experienced byincandescent lighting when the voltage sags. A voltage reduction may be an effect of disruption of anelectrical grid, or may occasionally be imposed in an effort to reduce load and prevent a power outage,knownas ablackout.

15. Define the term load curve and load duration curve. A-M 2024,N-D 2017

The curve drawn between the variations of load on the power station with reference to time is knownasload curve.

Thistypeofcurvewhichindicatesthevariationofload,butwiththeloadsarrangedindescendingorder ofmagnitude,i.e., thegreatestload on the leftand lesserloadstowards right.

16. Define load forecasting in powersystem.N-D2017

Theloadontheirsystemshouldbeestimatedinadvance.Thisestimationinadvanceisknownasloadforecasting.Loadforecastingbasedon theprevious experiencewithout anyhistoricaldata.

17. State the types and advantage soft computer based control in powersystem.A-M2015

Types:SCADA,EMS,ECC

Advantages:Computerizedcontrolsystemsprovidebenefitsthatcanbecategorizedintofourdistinctgroups:

- Time
- Money
- Informationmanagement
- Improvedwork conditions.

18. What are the requirements of planning the operation of a power system?

Planning the operation of a power system requires load studies, fault calculations, the design ofmeansforprotectingthesystemagainstlightningandswitchingsurgesandagainstshortcircuitsandstudies ofthestabilityofthe system.

Stepsto befollowed.

- Planningof power system.
- Implementationoftheplans.
- Monitoring of the system.Comparewith results

19. What is meant by Residential load and Commercial load?

Residentialload:Itconsistsofdomesticlights,fans,andotherappliancessuchasheaters,refrigerators,television, radio, air-conditioning,etc., has a highpeak duringevening.

Commercialload:ItincludesLightingsforshops,advertisinghoardings,hospitals,hotels,shoppingcomplex, theatres, etc.,Ithas two peaks,morningand evening

Demandfactor =0.9to 1.0;
Diversityfactor=1.1 to1.2;
Loadfactor=0.25to 0.3

20. State the factors affecting the load forecasting. A/M2018

- Tomeet out futuredemand
- Longterm forecasting–Preparingmaintenanceschedule of generatingunits, futureexpansion.
- Mediumterm–Predictionofmonsoonactionandhydroavailability
- Shortterm –Spinningreserve&Unitcommitment

21. Write the implications of high diversityfactor and list any two methods employed to increase the diversity factor. A/M2018

- Givingincentivesto someconsumers touse electricityinthenightorlightloadperiods.
- Usingday–lightsaving
- Staggeringtheofficetimings
- Havingtwoparttariffinwhichconsumerhastopayanamountdependentonthemaximumdemandofconsumer uses.

UNIT–2 REAL POWER FREQUENC CONTROL

1. State the types of ALFC for inter connected powersystem.N-D2017

- Flatfrequency Control
- Flattielinecontrol
- Frequencybias tie-linecontrol

2. Illustrate the conditions for proper synchronizing of alternators. A-M 2024,N-D2017

Theconditionsforoperatingtwo synchronousmachinesinparallelare:

- Terminalvoltagemustbesame.
- TheSpeed&system frequencymust besame.
- Phasesequencemust be same.

3. Explain the need for integral controller in ALFC.A-M2017

There is a considerable droop in speed on frequency of the turbine for a given speed changer setting.Such a large deviation (± 0.5 Hz) cannot be tolerated and we must develop some suitable control strategy toachieve much better frequency constancy. For this purpose, a signal from Δf is fed through an integrator tothe speed changer. The integral controller actuates the load reference point until the frequency deviationbecomeszero.Integral controller gives zero steady state error.

4. Define control area.A-M2017N-D2016, 2015,2014

A control area is defined as a system to which a common generation control scheme is applied. Theelectricalinterconnectionwithineachcontrolareaisverystrongascomparedtothetieswiththeneighbouring areas. All the generators in control area swing in coherently or it is characterized by a singlefrequency. It is necessary to be considered as many control areas as number of coherent group. Each controlareaof apowersystem should help tomaintain thefrequencyandvoltageprofileof theoverall system.

5. Specify the use of static &dynamic response of theALFC.N-D2016

Static response of an ALFC loop will informabout frequency accuracy,whereas, the dynamicresponse ofALFC loopwill inform about the stabilityoftheloop.

6. State the objective of tie–line bias control. A-M 2024, N-D 2022,M-J2016

The objective of tie-lines is to trade power with the systems or areas in the neighbor hood whosecostsforoperationcreatesuchtransactionscost-effective.Moreover,eventhoughnopowerisbeingtransmitted through the tie-lines to the neighbor hood systems/areas and it so happens that suddenly there isa loss of agenerating unit in one ofthe systems. During such typeof situations all the units in theinterconnectionexperienceanalterationinfrequencyandbecauseofwhichthedesiredfrequencyisregained. Let therebetwo controlareas andpower is to beexchanged fromarea1 toarea2.

7. Definearea controlerror. N-D 2018,M-J 2016

ACEisthechangeinareafrequencywhichwhenusedinintegralcontrolloopfocusedthe steadystatefrequencyerror to zero.

$ACE = \Delta P_{tie} + b\ \Delta f$ p.u MW (for multi area system)$ACE = \Delta f$ (for singleareasystem)

Where, b =Areafrequencybias.

ΔP_{tie}isthechangeintielinepower,

Δfisthechangeinfrequency.

8. State the advantage of AVR loopoverALFC.N-D2015

AVR loop is much faster than the ALFD loop and therefore there is a tendency, for the AVRdynamics to settle down before they can make themselves felt in the slower load– frequency controlchannel.

9. Brief theapplicationof secondaryALFCloopin powersystemnetworks.N-D2018,A-M2015

The application of secondary ALFC loop in power system network is to maintain desired megawattoutput of a generator unit and controlling the frequency of the larger interconnection. The frequency iscontrolled directly using ALFC so that the real power of power system is to be controlled. The frequency ininterconnectedsystem is alwayssubject to change duechangeinload and powercapabilityof tie-line.

10. States the control objective of two are a load frequency control. N-D 2014

1. Undernormaloperatingcondition,eachcontrolareashouldhavethecapacitytomeetitsownloadfromitsown spinninggenerator,plus thescheduled interchangebetweentheneighboringareas.
2. Underemergencyconditions,theenergycanbedrawnfromthespinningreservesofalltheneighboringareas immediatelydueto thesudden loss of generatingunit

11. State any two necessities to put alternators inparallel.M-J2014, N-D2013

1. Localor regionalpowerusemayexceedthe powerofasingle available generation.
2. Parallel alternators allow one or more units to be shut down for scheduled or emergency maintenancewhiletheload is beingsupplied with power.

12. State the assumptions made in dynamic response of uncontrolled case.M-J2014

1. Neglecttheturbinedynamics
2. Thespeedchangeractionisinstantaneous.

13. Define the function of load frequencycontrol.M-J,N-D2013

The function of load frequency control on a power system is to change the valve settings or gateopenings of a prime mover as a function of load variations in order to hold system frequency at a constantlevel. The prime mover is controlled hence in order to that the input of turbine can be controlled easily. Thisis the main function of Load Frequency Control in power system. The speed governor is the main andimportantprimarytool used in theLoad FrequencyControl (LFC).

14. Define Speed droop.M-J2013

In electrical power generation, droop speed control is a speed control mode of a prime mover drivinga synchronous generator connected to an electrical grid. This mode allows synchronous generators to run inparallel,so thatloads are sharedamonggeneratorsinproportion to theirpower rating.

15. Why are governors employed in Power System?

Governors are employed in power systems for sensing the bias in frequency which is the result of themodification in load and eliminate it by changing the turbine inputs such as the characteristic for speedregulation(R)andthegovernortimeconstant(T_g).Governor‟saimstolimitthedeviationinfrequencyinthe presence of changing active power load. Consequently, the load reference set point can be utilized foradjusting the valve/gate positions so as to cancel all the variations in load by controlling the generation ofpowerratherthan ensuingdeviation infrequencythrough Governorsemployed in powersystem.

16. Define regulation.

Regulationisdefinedaspercentageriseinfullloadatthespecifiedpowerfactoriswitchedoff,theexcitation being adjusted initiallytogivenormalvoltage.

Regulation=$\frac{E_0-V}{V}$

Where,E_0 =Noload voltage

V=On loadvoltage

Theregulationoftherealpoweroutputofthegeneratoranditsfrequency(speed)isdealtbytheAutomaticLoadFrequencyControl (ALFC)

17. What are the factors to be considered for increasing response in AVR?N/D14)

Tomakeexcitationfaster, the following maybeconsidered.

1. Provisionofseparate excitation fortheself-excited.
2. Reductionofnumberoffield turnstoreducethetime constant.
3. Provisionofnewarmaturewiningforhighervoltageoperation.
4. IncreasingtheceilingvoltagebydecreasingthepermanentexternalfieldcircuitresistanceorbyincreasingtheexcitationvoltageE.
5. Increaseofbothexcitationvoltageandfieldresistanceinthesameratio,sothatceilingvoltageisunalteredbut timeis constant.

18. List the various components in AVR loop.(A/M’08)

ThevariouscomponentsinAVR loopare,

1. Exciter
2. Comparator
3. Amplifier
4. Rectifier
5. Synchronousgenerator.

UNIT–3 REACTIVEPOWERCONTROL

1. Show that the shunt compensation improves critical voltage as well as the power factor. A-M 2015

Voltage stability of a system is affected by reactive power limit of the system. FACTs devicesimprove the reactive power flow in system thereby improving voltage stability and these are used forcontrolling transmission voltage, Power flow, dynamic response and reducing reactive losses in transmissionlines.ThispaperexplorestheeffectofSVConstaticvoltagestabilityandpresentstheeffectofStaticVAR

compensator (SVC) on Voltage Profile & Reactive Power for variable load conditions is investigated andpresents static methods like Modal Analysis, Two Bus Thevenin Equivalent and Continuation Power Flowmethods to predict the voltage collapse of the bus in the power system. FACTs controllers help to increasetheload abilitymargin ofthe power network.

2. Distinguish between rotor angle stability and short termvoltagestability.A-M2015

Rotor Angle Stability	Short-term VoltageStability
Itistheabilityofthesystemtoremaininsynchronismwhensubjected toadisturbance.	Itistheabilityofthesystemtomaintainsteadystatevoltagesatallthesystembuseswhen subjectedtoadisturbance.
The rotor angle of a generator depends on thebalance between the electromagnetic torque duetothegeneratorelectricalpoweroutputandmechanicaltorqueduetotheinputmechanical powerthroughaprimemover.	Unlikeanglestability,voltagestabilitycanalsobealongterm phenomenon.
Remaining in synchronism means that all thegeneratorselectromagnetictorqueisexactlybalancedbythemechanical torque.	On the other hand if voltage variations are due toslowchangeinload,overloadingoflines,generatorshittingreactivepowerlimits,tapchangingtransformersetc.thentimeframefor voltagestabilitycanstretchfrom1minutetoseveralminutes.
Themaindifferencebetweenvoltagestabilityandanglestabilityisthatvoltagestabilitydependsonthe balanceof reactivepower demandandgenerationinthe systemwhereasthe anglestabilitymainly dependsonthebalancebetweenrealpower generationand demand	

3. Statethefunctionof loadfrequencycontrol.N-D2017

Loadingofunitsareallocatedtoservetheobjectiveofminimumfuelcostisknownasautomaticloadscheduling.

4. State the advantages and disadvantages of synchronous compensators. N-D 2017, 2013Advantages:

- Flexibilityof operationforallload conditions.
- Asthelosses areconsiderable comparedwithstaticcapacitorsandthepower factorisnot zero.

Disadvantages:

- Thecostof installationishigh
- Lossesofsynchronouscondensersaremuchhighercomparedtothoseof capacitors.

5. Commentontheuse of seriescapacitorsin transmissionlines.A-M2017

- Thereactivepowerproduced bythe seriescapacitorincreaseswith theincreaseinpower transfer.
- Seriescapacitorsareconnectedinseriestocompensatetheinductivereactanceofline.Thisreducesthetransfer reactancebetween the busesto whichthe line isconnected.
- Itincreasesmaximumpowerthatcanbetransmittedandreducesreactivepowerloss.

6. Defineexciter ceilingvoltage.A-M2017

- Itis themaximum voltagethatmaybeattained byanexciter underspecificconditions.
- The voltage of the main exciter should be controlled from zero to ceiling voltage, the maximumvoltage that may be attained by the exciter under specified conditions, to obtain rapid correction ofexcitervoltageafter disturbanceor fault.

7. Statethevariousfunctionsof anexcitation system.N-D2016,2013

Thebasicfunctionofanexcitationsystemisto

- Providenecessarydirectcurrenttothefieldwindingofthesynchronousgenerator.
- The excitation system must be able to automatically adjust the field current to maintain the requiredterminal voltage. The DC field current is obtained from a separate source called an exciter.Theexcitationsystems havetaken manyformsover theyears of their evolution

8. Mentionthepurposeof seriescompensation.N-D2016

Purposeofseries compensation:

- IncreaseinPower TransferCapability
- ImprovementinSystemStability
- Load DivisionamongParallel Line
- ControlofVoltage

9. DefineSVC.M-J2016

SVC comprises of switched or fixed capacitor bank and switched reactor bank in parallel. Thesecompensators draw reactive power from the line thereby regulating voltage, improve stability (steady stateand dynamic), control overvoltage and reduce voltage and current unbalances. In HVDC application thesecompensators provide the required reactive power and damp out sub harmonic oscillations. Static VARcompensatorsuseswitchingfor VAR control. Theseare also called staticVAR switchesor systems.

10. Explainhowvoltageand reactivepowerinterrelated. M-J2016,2013

- Voltage control in an electrical power system is important for proper operation for electrical powerequipment to prevent damage such as overheating of generators and motors, to reduce transmissionlossesandto maintain theabilityof thesystem towithstand and prevent voltage collapse.
- Ingeneralterms,decreasing reactive power causing voltage tofallwhile increasing itcausingvoltage to rise. A voltage collapse occurs when the system try to serve much more load than thevoltage can support.
- When reactive power supply lower voltage, as voltage drops current must increase to maintain powersupplied,causingsystemtoconsume morereactivepowerand thevoltagedrops further.
- Ifthecurrentincreasetoomuch,transmissionlinesgooffline,overloadingotherlinesandpotentiallycausing cascadingfailures.

11. Statetheroleofexciter.N-D2015

The exciter is the main component in AVR loop.It delivers the DC power to the generator field.It musthave adequate power capacity and sufficient speed of response (rise time less than 0.1 sec). The excitercontrol is the major important concern in the reactive power control of power system. By controlling thevoltage can control the reactive power. The main function of the exciter is to provide Direct Current to thesynchronous motor. The control functions which are provided for exciter are control of voltage and reactivepowerflowand the enhancement ofsystem stability.

12. Definestabilitycompensation. N-D2015

Compensation consists of injecting reactivepower to improve power system operation to keep voltagesclose to nominal values. It reduces the line currents and hence network losses then improve the stabilityenhancement. It Compares the Generator terminal voltage with a preset reference voltage. If the Generatorterminal voltage is less than the reference voltage, the AVR increases D.C. voltage across the Generatorfield, maintaining the constant voltage as per the setting. Stability compensation improves the dynamicresponsecharacteristicswithoutaffectingthe static loopgain.

13. Statetherelation betweenvoltage, powerand reactivepowerata node.N-D 2014

The voltage drop in the transmission line is directly proportional to the reactive power flow (Q-flow)in the transmission line.Most of the electric load is inductive in nature. In a day, during the peak hours, Q-flow will be heavy, resulting more voltage drop. However, during off-peak hours, the load will be very smalland the distributed shunt capacitances throughout the transmission line become predominant making thereceiving-endvoltagegreaterthanthesending-endvoltage(Ferrantieffect).Thusduringoff-peakhourstheremaybevoltageriseín thetransmission linefrom sending-end to receiving-end.

$\frac{\partial Q}{\partial V}=\frac{E-2V}{X}$ IfXissmall, $\frac{\partial Q}{\partial V}$ islarge.

14. Statetheadvantagesof Switched capacitorsin voltagecontrol. N-D2018,2014

TheSCbehaveslikearesistorwhosevaluedependsoncapacitanceCSandswitchingfrequencyf.TheSC

resistor is used as a replacement for simple resistors in integrated circuits because it is easier to fabricatereliably with a wide range of values. It also has the benefit that its value can be adjusted by changing theswitchingfrequency(i.e.,it is a programmable resistance).

- Powerfactorimprovement.
- Efficiencyoftransmission anddistribution ofpower ishigh.
- Reactivepowercompensation.
- Lesscostly.
- Improvefeedervoltagecontrol.

15. Wherearesynchronouscondensersinstalled?M-J2014

InIndustriesinorderfor Powerfactorcorrection andneedtomaintainPowerfactor withinlimits.

16. State the different types of staticVARcompensators.N-D2018,M-J2014

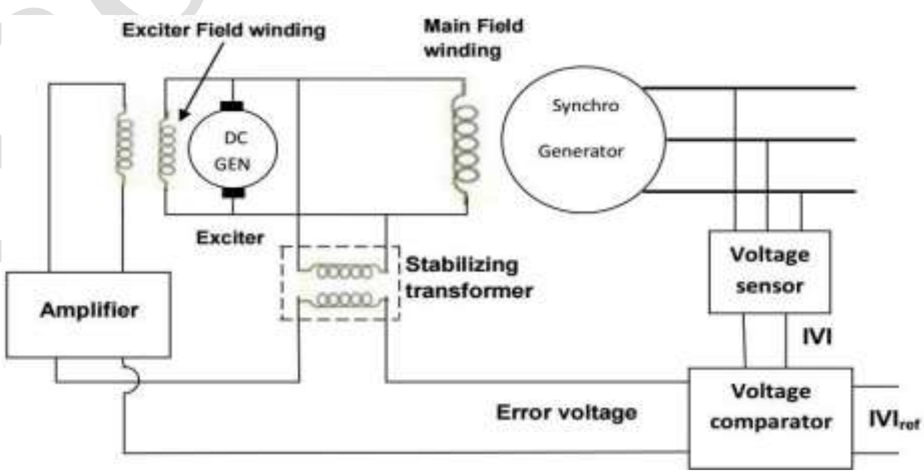
- SaturatedReactors[SR]
- ThyristorControlledReactors[TCR]
- ThyristorSwitchedCapacitors[TSC]
- ThyristorControlledTransformers[TCT]
- ThyristorSwitchedCapacitors[TSC]

17. State the functions of AVR.M-J2013

The function of the Automatic Voltage Regulator (AVR) is to maintain constant voltage andpower line conditioning to the load under a wide variety of conditions, even when the utility inputvoltage,frequencyor system load varywidely.

TheAutomaticVoltageRegulator(AVR)ismainlyresponsibleforregulatingsystemvoltagewithoutviolatingthe limit which indirectlycontrolsthe reactivepower of a system.

18. Draw the typical block diagram of DC excitation system.



DC excitation system utilizes DC generators as sources of excitation power and provide current to the rotorofthe synchronous machine through slip rings.

19. Writethedifferentmethodsof voltagecontrol.

Thedifferentmethodsof voltagecontrolare,

- Excitationcontrol,
- StaticShuntcapacitors
- StaticShuntreactor,
- Synchronouscompensator
- Tapchangingtransformer,
- BoosterTransformer,
- RegulatingTransformer and
- StaticVARcompensator.

20. WritetheobjectivesofFACTScontrollersinthepowersystemnetworkandthemainareasofapplication ofFACTS devices.

Objectivesof FACTScontrollers

- Betterthecontrolofpowerflow(RealandReactive)intransmissionlines.
- LimitsSCcurrent
- Increasetheloadabilityofthe system
- Increasedynamic andtransientstabilityofpower system
- Loadcompensation
- Powerqualityimprovement

FACTSmainlyfindapplicationin followingareas,

- Powertransmission
- PowerQuality
- RailwayGridConnection
- Windpower gridConnection
- CableSystems

21. State the main objective of Reactive power and voltage control in power system. A-M 2024, A-M2018

Forefficientand reliable operationofpowersystemshouldhavethefollowing.

- Allmachinesaredesignedtooperateatacertainvoltage–Above/belowratedvoltagecausedamagesto them
- Systemstabilityisincreaseddduetomaximumutilizationoftransmissionline.
- ReactivepowerflowisminimizedsoastoreduceI^2RandI^2Xlossesandtooperatethetransmissionsystemefficiently.

22. OutlinetheroleofSynchronousgeneratorsadoptedforgenerationandabsorptionofreactivepower.A-M2018

Over excited – Generate Reactive powerUnderexcited– Absorptionofreactivepower

UNIT–4– UNITCOMMITMENT&ECONOMICSDISPATCH

1. Find the incremental transmission losses for a two area power system, where the bus voltages arekept fixed and the line power flow is a function of line angle. Power loss is a function of generation ofareaB only. A-M2015

Itisevidentthat,

$P_l = f(P_{gB})$

ThisalsosuggeststhattheincrementtransmissionlossforgridAwillbezeroandtheincrementaltransmissionloss of thelinewill begoverned bythegrid Bonly.

Thus,

Economic operation being dictated by the criterion,

$$\lambda = \frac{(IFC)_A}{1-(ITL)_A} = \frac{(IFC)_B}{1-(ITL)_B}$$

In this case for economic operation,

$$\lambda = \frac{(IFC)_A}{1-0} = \frac{(IFC)_B}{1-(ITL)_B}$$

2. Definespinningreserve.A-M2015,M-J2014,2015

Spinning reserve is the total amount of generation availability from all units synchronized on the systemminusthepresent load and losses beingsupplied.

SpinningReserve=[Totalamountofgeneration]–[PresentLoad+Losses]

Spinning reserve must be established, so that the loss of one or more units does not cause drop in systemfrequency. (i.e. if one unit is lot, the spinning reserve unit has to make up for the loss in a specified timeperiod.

Spinningreserveis thereserve generatingcapacityrunningat zero load or noload.

3. DefineFLAPC.N-D 2017,2013

FLAPC-FullLoadAverageProductionCost

Fullloadaverageproductioncost ={netheatrate at fullload}*{fuelcost}

FLAPC=$\frac{C_i()}{P_{Gi}} = \frac{K.H_i()}{P_{Gi}}$

4. State the conditions for the optimal power dispatchinalosslesssystem.N-D2017,2013 Thenecessaryconditionfortheexistenceofaminimumcostoperatingconditionisthattheincrementalcostratesofallthe units be equal to some undetermined value (λ)called Lagrangian multiplier.

$\lambda_i = \frac{dF_i}{dP_i}$

5. Stateтheconstraintsinunitcommitment.A-M2017,N-D2014

- Spinningreserveconstraints
- Thermalunitconstraintsare,
  - Minimumuptime
  - Minimum downtime &
  - Crewconstraints.
- OtherConstraints
  - HydroConstraints
  - MustRun Constraint
  - FuelConstraint

Forasinglevalueturbinethegoverningisdonebythrottlingofsteamandforsuchunits,theinput-outputcurveis substantiallyastraight line within its operatingrange**.**

6. Define incremental cost in power dispatch. A-M 2017

Incremental Cost = $\frac{Small\,Change\,in\,input}{Small\,Change\,in\,output} = \frac{dC_i(PC_i)}{dP_{Gi}}$

7. Write the coordination equation taking the effect of transmission losses. N-D 2016

In this case for economic operation,

$$\lambda = \frac{(IFC)_A}{1-0} = \frac{(IFC)_B}{1-(ITL)_B}$$

8. Write the relationship between fuel energy input and input fuel cost, give the quadratic expression of fuel cost.

Relationship between fuel energy input and input fuel cost

Input fuel cost $F_i(P_i) = K.F_i(P_i)$ Rs/hr

Where, K = Cost of the fuel inRs/MKcal.

$F_i(P_i)$ = Fuel energy input in MKcal/hr.

Quadratic expression of fuel cost

$F_i(P_i) = = \alpha_i (P_i) + \beta_i (P_i) + \gamma_i$ Rs/hr

Where α_i, β_i, γ_i are constants.

(P_i)=Power generation.

9. Define priority list method. M-J 2016

Priority list method is the simplest unit commitment solution method which consists of creation a priority list of units.

The priority list can be obtained by noting the full-load average production cost of each unit.

Full load average production cost = {net heat rate at full load} *{ fuel cost }

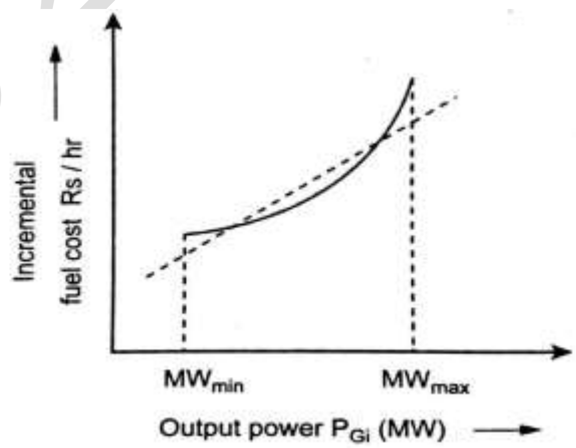
$$FLAPC = \frac{C_i(P_i)}{P_{Gi}} = \frac{K.H_i(P_{Gi})}{P_{Gi}}$$

10. Define incremental transmission loss. M-J 2016

$$\frac{\partial PL_L}{\partial PG_i} = ITL$$

11.Draw incrementalfuelcostcurve.N-D 2015,M-J2015,2016

Theslopeoffuelcostcurvei.e.,$\frac{dC_i}{dP_{Gi}}$Rs/MWhcanbeobtainedbydifferentiatingequationwithrespectto P_{Gi}.

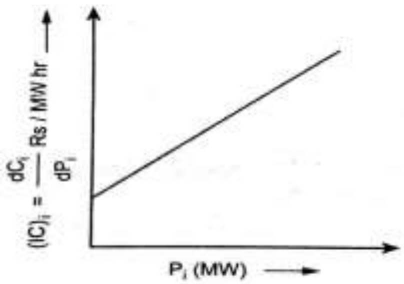


12.Definecrew constraints. N-D2018, 2015

If a plant consist of two (or) more units, all the units cannot be turned on at the same time since thereare not enough crew members to attend both units while starting up. In a plant with more than one unit theremay not be enough personnel to attend both the units if both are turned on or off at the same time and henceat the same time both cannot be turned on or off. A certain amount of energy is expended to bring the uniton-line.This is not generatedand is included in theunit commitment problem asa start-upcost.

13.Draw theincrementalcostcurveofthermalunit.N-D2014

Incrementalcostcurveof thermal unitis plottedwith thederivativeofthefuelcost curveversus realpower



14.Writetheequalityandinequalityconstraintsconsideredintheeconomicdispatchproblems(N/D’11)

Thepowersystemhastosatisfyseveralconstraintswhileinoperation.Thesemaybebroadlydividedintotwotypes,

Equalityconstraints:

Thefirstofthesearisesoutofthenecessityforthesystemtosatisfyloadbalanceandarecalledequalityconstraints.

Inequalityconstraints:

Anumberofotherconstrainsduetophysicalandoperationallimitationsoftheunitsandcomponentswillarisein economicscheduling. Thesearein theform of inequalityconstraints.

Eachgenerator inoperationwillhave a minimumandmaximumpermissible outputandthe productionmustbeconstrained toensurethat

$P_{1min} < P_1 < P_{1max}$

15.Distinguishbetweeneconomicdispatch&unitcommitment.N-D2018,A-M2018,M-J2014

EconomicDispatch	**UnitCommitment**
Optimumallocationofgenerationtoeachstation. (At each generating station at variousstationload levels)	Optimum allocation of number of units to beoperated(todeterminetheunitsofaplantthatshouldo perateforagivenloadisthe problemofunitcommitment)
Theproblemassumesthatthereare„n‟unitsalreadyconne cted to thesystem.	Therearenumberofsubsetsofthecompletesetof„n‟unit sthatwouldsatisfythe expecteddemand.
Purposeofeconomicdispatchproblemsistofindtheoptim umoperatingpolicyforthese „n‟units.	Purposeofunitcommitmentistofindtheoptimalsubset amongthesubsetswhich providetheminimum operatingcost.

16.Writetheconditionforminimumuptime.(A/M’11)

Once the unit is running, it should not be turned off immediately. This is the condition for minimumuptime. Generally more generators are started upataround the peak load, and few units are started up atlight loads based on full load average production cost. To satisfy minimum up time constraint the units areset continuouslyin ON condition.

17.Listthetechniquesforthesolutionof theunitcommitmentproblem.

The various techniques involved in unit commitment problem are listed as follows.Theyare,

- Prioritylist method
- Dynamicprogramming
- Bruteforcetechnique.

Arecentliteraturereviewidentifiednineofthesemethodologies:prioritylistmethod,dynamicprogramming, Lagrangian relaxation, genetic algorithms, simulated annealing, particle swarm optimization,fuzzylogic algorithm, and evolutionaryprogramming.

18.ListoutthereasonsforchoosingtheLRalgorithm.(A/M'13)

- SpecifiedfortheUnitCommitmentProgram.
- Flexibleindealingwithvarioustypesofconstraints.
- Flexibletoincorporateadditionalcouplingconstraintsthathavenotbeenconsideredsofar.
- Flexible becausenopriorityorderingisimposed

Computationally muchmoreattractive forlargesystem sincetheamount ofcomputation varies withthenumberofunits.

19.Whatistheneedofeconomicdispatchcontrol?

a. Economicdispatchdeterminesthebestwaytominimizethecurrentgeneratoroperatingcosts.
b. Theλ-iterationmethodis agoodapproach forsolvingthe economicdispatchproblem:
   i. Generatorlimits areeasilyhandled.
   ii. Penaltyfactors areusedto consider theimpact of losses.
c. Economicdispatchisnotconcernedwithdeterminingwhichunitstoturnon/off(thisistheunitcommitmentproblem).

Basicformofeconomicdispatchignoresthe transmissionsystemlimitations.

20.Relatethenecessaryconditionfortheexistenceofminimumcostoperationforthethermalpowersystem.A-M2018.

- OptimalLoading
- RegularMaintenance
- Adoptenergyefficientequipmentandprocess.

UNIT–5 COMPUTER AIDED CONTROL OF POWER SYSTEM

1. StatetheroleofSCADAplaysin electricalpowersystems.A-M2015

ModernSCADAsystemsarealreadycontributingandplayingakeyroleatmanyutilitiestowardsachieving:

• Newlevelsinelectricgridreliability–increasedrevenue.
• Proactiveproblemdetectionandresolution–higherreliability.
• Meeting the mandated power quality requirements – increased customer satisfaction.Realtimestrategic decisionmaking – cost reductionsand increased revenue

2. Definetheresponsibilitiesofregionalloaddispatchcentre.A-M2015

ThemainresponsibilitiesofRLDCsare:

♦ Systemparametersandsecurity.
♦ Toensuretheintegratedoperationofthepower system gridintherespectiveregion.
♦ Systemstudies,planningandcontingencyanalysis.
♦ Dailyschedulingand operationalplanning.
♦ Facilitatingbilateral andinter-regional exchanges.
♦ Computationof energydispatch and drawnvalues usingSEMs.
♦ Augmentationoftelemetry, computingandcommunicationfacilities.

3. DefineSCADA.N-D2017

SCADA stands for supervisory control and data acquisition system. It allows a few operators tomonitor the generation and high voltage transmission systems and to take action to correct overloads. Thesupervisory system may be combined with a data acquisition system by adding the use of coded signals overcommunication channels to acquire information about the status of the remote equipment for display or forrecordingfunctions.It isatypeof industrial control system (ICS).

4. DefineStateestimation.N-D2017,M-J2016,N-D2013,M-J2013

Stateestimationisdefinedastheprocessofassigningavaluetoanunknownsystemstatevariablebasedonthe measurements from that system accordingto somecriteria.

1. Real-timedataprimarilycomefromSCADA
2. SEsupplementsSCADAdata: filter,fill,smooth.
3. Toprovideaconsistent representationforpower systemsecurityanalysis

5. Listouttheconditionsfornormaloperationof apowersystem.A-M 2017

- Controllerneedstooperatethesystemas economic.
- Voltage& Frequencyareneeds to keepclose to normal.

6. Defineenergycontrolcentre. A-M 2024,A-M2017

Whenthe power system increases in size, their operation and interaction become more complex. So, itbecomes essential to monitor this information simultaneously for the total system which is called EnergycontrolCentre.

7. StatethefunctionsofSCADA.N-D2016,M-J2016,N-D2013,M-J2013

Thedataacquisitionandcontrolsystemperformsthefollowinggeneralfunctions.

a. Dataacquisitionand validation,
b. Realtimevariablecomputations,
c. Alarmmonitoringand display,
d. Performanceanddeviationcalculation,
e. Trends,events,reportsandlogs,
f. Sequentialcontrol,
g. Modulatingcontrol
h. Otherrelatedfunctions.

8. Statethe majorfunctions thatarecarriedout inanoperationalcontrol centre.N-D2016

- System LoadForecasting-Hourlyenergy,1to7days.
- Unitcommitment-1to7days.
- Economicdispatch
- Hydro-thermalscheduling-upto7days.
- MW interchangeevaluation-with neighbouringsystem
- Transmissionlossminimization
- Securityconstraineddispatch
- Maintenancescheduling,Productioncostcalculation

9. Explain thestatesof powersystem.N-D2015

- Normalstate
- Alertstate
- Emergencystate
- Extremisstate
- Restorativestate

10. Statethefunctionsof controlcentre.N-D2015

FunctionsofControlCentre.

- SystemMonitoring
- DataAcquisitionandControl

11. Definepowersystemsecurity. N-D 2014

Itisdefinedasthedegreeofriskintheabilitytosurviveimminentdisturbances(contingencies)withoutinterruptionofcustomers ervice.

Itdependsupontheresevecapacityavailableinagivensituationandthecontingencyprobabilityofadisturbance.

12. Listtheapplicationof SCADA.N-D 2014

Asthepowersystemdealswithpowergeneration,transmissionanddistributionsectors,monitoringisthemainaspect inall theseareas.Thus theSCADAimplementation ofpower system improves

- Theoverall efficiencyofthe system for optimizing
- Supervisingandcontrollingthe generationandtransmissionsystems,
- Greatersystemreliabilityand
- Stabilityforintegratedgridoperation.

13. Statetheobjectives of AGC.M-J2014

Theobjectives of AGC are

- To hold frequencyat or veryclose to a specifiednormal value.
- Tomaintainthecurrentvalueofinterchangepowerbetweencontrolareas.
- Tomaintaineachunitsgenerationatthe mosteconomicvalue.

14. Definerestorativestate.M-J2014

Tobringtheextremisstateback tonormalthrough therestorativestatethisisaslowerprocess.

From this state, the system may be brought back either to alert state or secure state.The latter is a slowprocess. Hence, in certain cases, first the system is brought back to alert state and then to the secure state.Thisis doneusingrestorativecontrol action.

15. DefineNetworkTopologyinaPowerSystem.

In order to run the state estimation, wemustknowhowthetransmissionlineareconnectedtotheloadandgenerationbuses. This information is called network topology.

16. List out the functions of Energy management system. A-M 2024, A-M2018

- System LoadForecasting-Hourlyenergy,1to7days.
- Unitcommitment-1to7days.
- Economicdispatch
- Hydro-thermalscheduling-upto7days.
- MW interchangeevaluation-with neighboringsystem
- Transmissionlossminimization
- Securityconstraineddispatch
- Maintenancescheduling
- Productioncostcalculation.

17. Point out the objectives of Load Frequency Control.

Loadfrequencycontrol(LFC)hastoachievethreeprimaryobjectives,whicharestatedbelowinpriorityorder:

- Tomaintainfrequencyatthescheduledvalue.
- Tomaintainnetpowerinterchangeswithneighbouringcontrolareasatthe scheduledvalues.
- Tomaintain powerallocation amongunitsat economicallydesired values.

18. Write about RTU and Master Station in SCADA.

RemoteTerminalUnits(RTU):RTUsaremicroprocessorcontrolledelectronicdevicesdeployedinfieldatspecificsitesand locations.TheycollectnecessarydataandtransmitthemtoSCADA forprocessing.

MasterUnit:Itisalargecomputersystemwhichservesas acentralprocessor.
CommunicationLinksFibreoptic/satellite/microwavecommunicationsareemployedtolinkRTUswithSCADA.

19. List out the National Regional Electricity Boards.

Thenational regionalelectricityboardsare,

- NorthernRegionalElectricityBoard
- WesternRegionalElectricityBoard
- SouthernRegionalElectricityBoard
- EasternRegional ElectricityBoard
- North-eastRegionalElectricityBoard

20. State the Weighted Least Square Criterion.A-M2018,N-D2018

Theobjectiveistominimizethesumofthesquaresoftheweighteddeviationsoftheestimatedmeasurements[F(X)]from theactual measurements [Z].

21. What are the priorities for operation of modern power system? N-D 2018

- EconomicOperation
- FrequencyRegulation
- VoltageRegulation
- Powerfactormaintenance
- Load forecastingandScheduling
- Abilityto Restructure.

PART– B

UNIT 1

1. What are the components of speed governor system of an alternator? Derive a transfer function and sketch a block diagram.
2. With neat sketch describe the P-F and Q-V control structure.N-D 2022
3. Briefly discuss the classification of loads and list out the important characteristics of various types of loads.
4. Problem (Load Curve)
5. Explain the method availabilities for providing economic operation of power system.
6. Write short notes on load v curve load duration curve energy curve.
7. Explain about spinning reserve, hot reserve, cold reserve.
8. What is load forecasting? also discuss about the computational methods available for it. A-M 2024
9. Explain the necessesity of voltage and frequency regulation in power system. A-M 2024

UNIT 2

1. Explain load frequency control.
2. Draw the block diagram of LFC control of single area and derive the dynamic response.
3. Develop the block diagram model of uncontrolled two area load frequency control system and explain the salient features under static conditions. A-M 2024
4. Explain Interconnected operation.
5. Explain the solution technology for solving priority list method by dynamic programming method.
6. Explain the static state estimation of power system.
7. List out the components of speed governor system of an alternator derive its transfer function with the help of block diagram. A-M 2024, N-D 2022

UNIT 3

1. Draw the circuit diagram for a typical excitation system and derive the transfer function model and draw the block diagram.
2. Discuss generation and absorption of reactive power.
3. Explain different types of static VAR compensators with a phasor diagram.
4. Discuss about the various methods of voltage control. A-M 2024
5. Derive the relations between voltage, power and reactive power at a node for applications in power system control.

UNIT 4

1. Derive the coordination equation with losses neglected.
2. Derive the coordination equation of an ‘n’ bus power system taking into account the effect of system losses.
3. Derive the expression for base point and participation method.
4. State the unit commitment problem. With the help of flowchart explain forward dynamic programming solution method. A-M 2024
5. Explain Priority list method using full Load average production cost. State the merits and demerits.
6. Numerical problems in economic dispatch & unit commitment A-M 2024

UNIT 5

1. Briefly discuss the various functions of energy control centre.
2. Explain the different operating states of power system with state transition diagram.
3. Explain the hardware components of SCADA with neat diagram and also mention the functions of it. A-M 2024
4. Explain about power system security
5. What is EMS? What are its major functions in power system operation and control? A-M 2024

Faculty Incharge **Head of the Department**
(P.Thenmozhi) **(N.Vijayasarathi)**

HoDRemarks: