**NANDHA ENGINEERING COLLEGE**
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## DEPARTMENT OF ELECTRICAL AND ELECTRONICS

**POWER SYSTEM OPERATION AND CONTROL**

## UNIT – 1
## INTRODUCTION

| S.No | Part – A | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | State the objectives of power system control. | 2 | 1 | U | An overview of power system operation and control |
| 2 | Mention the importance of plant level and system level controls. | 2 | 1 | R | plant level and system level controls |
| 3 | Define load curve | 2 | 1 | R | load Characteristics |
| 4 | Distinguish between load curve and load duration curve. | 2 | 1 | U | load curves and load-duration curve |
| 5 | Define load duration curve | 2 | 1 | R | load curves and load-duration curve |
| 6 | Delineate annual load curve. | 2 | 1 | R | load curves and load-duration curve |
| 7 | Delineate the term load factor | 2 | 1 | U | diversity and load factor |
| 8 | Delineate the term diversity factor | 2 | 1 | R | diversity and load factor |
| 9 | List out the various types of load forecasting | 2 | 1 | U | load forecasting |
| 10 | State the need for the load forecasting in a power system | 2 | 1 | R | quadratic and exponential curve fitting techniques. |

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### POWER SYSTEM OPERATION AND CONTROL

| S.No | Part – B | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Draw and explain the basic P-f and Q-V control loops | **8** | **1** | AN | An overview of power system operation and control |
| 2 | With neat block diagram, explicate the overview of power system operation and control | **8** | **1** | U | plant level and system level controls |
| 3 | Explore the following terms:<br>(i)Hot Reserve<br>(ii)Cold Reserve<br>(iii)Spinning Reserve | **16** | **1** | **U** | load Characteristics |
| 4 | Describe various types of reserve requirements in power system | 16 | 1 | R | load curves and load-duration curve |
| 5 | A power station has to meet the following demand<br>Group A: 200 KW between 8 A.M and 6 P.M<br>Group B: 100 KW between 6 A.M and 10 A.M<br>Group C: 50 KW between 6 A.M and 10 A.M<br>Group D: 100 KW between 10 A.M and 6 P.M and then between 6 P.M and 6 A.M. Plot the daily load curve and determine (i) diversity factor (ii) units generated per day (iii) load factor | **16** | **1** | **U** | diversity and load factor |

<table>
<tr><td>6</td><td>A generating station has the following daily load cycle:<br><table><tr><td>Time(Hours)</td><td>0 to 6</td><td>6 to 10</td><td>10 to 12</td><td>12 to 16</td><td>16 to 20</td><td>20 to 24</td></tr><tr><td>Load (MW)</td><td>20</td><td>25</td><td>30</td><td>25</td><td>35</td><td>20</td></tr></table><br>Plot the daily load curve and calculate (i) Maximum Demand (ii) Units generated per day (iii)Average load and (iv) Load Factor</td><td>16</td><td>1</td><td>R</td><td>diversity and load factor</td></tr>
<tr><td>7</td><td>Define load forecasting. Elucidate the different types of load forecasting.</td><td>8</td><td>1</td><td>Ap</td><td>load forecasting</td></tr>
<tr><td>8</td><td>Elucidate the curve fitting techniques of load forecasting with an example.</td><td>16</td><td>1</td><td>Ap</td><td>quadratic and exponential curve fitting techniques.</td></tr>
<tr><td>9</td><td>Compare various stochastical methods of load fore casting</td><td>16</td><td>1</td><td>A</td><td>quadratic and exponential curve fitting techniques</td></tr>
<tr><td>10</td><td>Compare various stochastical methods of load fore casting</td><td>16</td><td>1</td><td>Ap</td><td>Quadratic and exponential curve fitting techniques.</td></tr>
</table>

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**POWER SYSTEM OPERATION AND CONTROL**

## UNIT – II

## REAL POWER - FREQUENCY CONTROL

| S.No | Part – A | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Outline the need for voltage regulation in power systems | **2** | **2** | **R** | Basics of speed governing mechanism and modeling |
| 2 | Reveal the significance of droop characteristics | **2** | **2** | **R** | speed-load characteristics |
| 3 | Define per unit droop. | **2** | **2** | **U** | speed-load characteristics |
| 4 | Pin point the necessary condition for synchronizing two machines. | **2** | **2** | **AP** | load sharing in parallel operation |
| 5 | Point out the two conditions for proper synchronizing of alternators. | **2** | **2** | **U** | load sharing in parallel operation |
| 6 | Intend the control area concept in power system. | **2** | **2** | **R** | control area concept |
| 7 | State the basic role of ALFC. | **2** | **2** | **R** | LFC control of a single-area system |
| 8 | What is meant by AFRC? | **2** | **2** | **AP** | LFC control of a single-area system |
| 9 | Delineate the function of Load Frequency Control in power system. | **2** | **2** | **AP** | LFC control of a single-area system |
| 10 | Differentiate static and dynamic response of an ALFC loop. | **2** | **2** | **U** | Static and dynamic analysis of uncontrolled and controlled cases. |

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| S.No | Part – B | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Expound the speed governing mechanism system and derive the transfer function model with an aid of a block diagram. | **16** | **2** | **An** | Basics of speed governing mechanism and modeling |
| 2 | Draw the speed load characteristics of Two Synchronous Machines in Parallel | **16** | **2** | **C** | speed-load characteristics |
| 3 | Two generators rated 400 MW and 700 MW are operating in parallel. The droop characteristics of their governors are 3% and 4% respectively from no-load to full load. Assuming that the governors are operating at 50 Hz at no load, how would a load of 1000 MW be shared between them? What will be the system frequency at this load? Assume linear governor operation. Determine the full load speed for each machine | **8** | **2** | **AP** | speed-load characteristics |
| 4 | Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 5% respectively from no-load to full load. Assuming that the governors are operating at 50 Hz at no load, how would a load of 600 MW be shared between them? What will be the system frequency at this load? Assume linear governor operation. Determine the full load speed for each machine | **8** | **2** | **AP** | load sharing in parallel operation |
| 5 | Derive an expression for load sharing between two alternators. | **8** | **2** | **AP** | load sharing in parallel operation |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Derive the transfer function model and draw the block diagram for single control area provided with governor system. From transfer function derive the expression for steady state frequency error | **16** | **2** | **AP** | control area concept |
| 7 | Develop the mathematical model for controlled case of single area load frequency control system under static condition with necessary block diagram. | **16** | **2** | **AP** | LFC control of a single-area system |
| 8 | Explicate uncontrolled case of single area load frequency control system under static condition with block diagram. | **16** | **2** | **An** | LFC control of a single-area system |
| 9 | Develop the mathematical model for controlled case of single area load frequency control system under dynamic condition with necessary block diagram. | **16** | **2** | **An** | LFC control of a single-area system |
| 10 | Develop the mathematical model for controlled case of single area load frequency control system under dynamic condition with necessary block diagram. | **16** | **2** | **AP** | static and dynamic analysis of uncontrolled and controlled cases. |

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**POWER SYSTEM OPERATION AND CONTROL**

**UNIT – III**

**REACTIVE POWER– VOLTAGE CONTROL**

| S.No | Part – A | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | State the functions of AVR | **2** | **3** | U | Automatic Voltage Regulator (AVR)- |
| 2 | State the sources of reactive power. | **2** | **3** | AN | Generation and absorption of reactive power |
| 3 | Incise the importance of voltage control in power system. | **2** | **3** | AN | basics of reactive power control |
| 4 | Reveal the various functions of excitation system. | **2** | **3** | AN | excitation systems |
| 5 | State the condition to determine K value of AVR loop. | **2** | **3** | U | modeling |
| 6 | List out the various components in AVR loop. | **2** | **3** | R | static and dynamic analysis |
| 7 | Define Stability compensation | **2** | **3** | U | stability compensation |
| | Give some of the Static compensators schemes. | **2** | **3** | U | methods of voltage control |
| 9 | List out the merits of synchronous compensator | **2** | **3** | AN | Tap changing transformer, SVC (TCR + TSC) and STATCOM. |
| 10 | List out the properties of static compensators. | **2** | **3** | AP | Tap changing transformer, SVC (TCR + TSC) and STATCOM. |

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### POWER SYSTEM OPERATION AND CONTROL

| S.No | Part – B | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Draw the diagram of a typical automatic voltage regulator and develop its block diagram representation. | **8** | **3** | **Ap** | Automatic Voltage Regulator (AVR)- |
| 2 | Elucidate the generation and absorption of reactive power for various electrical equipments in power system. | **16** | **3** | **Ap** | Generation and absorption of reactive power |
| 3 | Explore how voltage control can be affected by injection of reactive power. | **16** | **3** | U | basics of reactive power control |
| 4 | Explore the working of static excitation system. | **16** | **3** | E | excitation systems |
| 5 | With neat block diagram enlighten voltage control of automatic voltage regulator in a power system under static condition. | **8** | **3** | E | modeling |
| 6 | Develop the mathematical model for controlled case of single area load frequency control system under static condition with necessary block diagram. | **8** | **3** | U | static and dynamic analysis |
| 7 | Elucidate the various methods for stability compensation | **8** | **3** | AN | stability compensation |
| 8 | Elucidate the operation of STACOM for voltage control with neat block diagram. | **8** | **3** | AN | methods of voltage control |
| 9 | Elucidate the operation of tap changing transformer for voltage control with neat diagram. | **8** | **3** | AP | Tap changing transformer, |
| 10 | Explicate the operation of SVC – TSC & TCR with neat block diagram | **16** | **3** | AP | SVC (TCR + TSC) and STATCOM. |

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**POWER SYSTEM OPERATION AND CONTROL**

**UNIT – IV**

**UNIT COMMITMENT AND ECONOMIC DISPATCH**

| S.No | Part – A | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Define economic dispatch problem. | **2** | **4** | U | Formulation of economic dispatch problem |
| 2 | Define participation factor with respect to economic dispatch problem. | **2** | **4** | AN | I/O cost characterization |
| 3 | Draw the incremental cost curve for thermal power plant. | **2** | **4** | AN | incremental cost curve |
| 4 | Write the coordination equation neglecting losses. | **2** | **4** | AN | coordination equations without and with loss |
| 5 | Delineate the term Lagrangian multiplier | **2** | **4** | U | solution by direct method and λ-iteration method |
| 6 | State the different constraints in unit commitment. | **2** | **4** | R | statement of unit commitment problem |
| 7 | Define priority list method. | **2** | **4** | U | priority-list method |
| 8 | State the merits and demerits of priority list method | **2** | **4** | U | priority-list method |
| 9 | State the advantages of using forward dynamic programming. | **2** | **4** | AN | forward dynamic programming |
| 10 | State the assumptions made in dynamic programming problem. | **2** | **4** | AP | forward dynamic programming |

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| S.No | Part – B | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | The fuel inputs per hour of plants 1 and 2 are given as $F1=0.2\ P_1^2+40P_1+120Rs/hr.$ $F2=0.25P_3^2+30P_2+150Rs/hr.$ Determine the economic operating schedule and the corresponding cost of generation of the maximum and minimum loading on each unit is 100 MW and 25 MW. Assume the transmission losses are ignored and the total demand is 180 MW. Also determine the saving obtained if the load is equally shared by both the units. | **16** | **4** | **An** | Formulation of economic dispatch problem |
| 2 | A power plant consists of two 200MW units, whose input cost data given by $F1=0.004\ P_1^2+2.0P_1+80Rs/hr.$ $F2=0.006P_3^2+1.5P_2+100Rs/hr.$ For the total load of 250MW ,what should be the division of load between two units for most economic operation. | **16** | **4** | **An** | I/O cost characterization |
| 3 | Explain the term incremental cost curve of power system related with economic dispatch. | **16** | **4** | **An** | incremental cost curve |
| 4 | Derive the coordination equations without and with loss | **16** | **4** | **An** | coordination equations without and with loss |
| 5 | Formulate the economic dispatch problem and derive the exact coordination equation. | **16** | **4** | U | coordination equations without and with loss |
| 6 | The fuel –cost functions for three | **16** | **4** | AN | solution by |

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|---|---|---|---|---|---|
| | thermal plants in Rs/hr are given by<br>F1=0.004 $P_1^2$+5.3 $P_1$+500Rs/hr.<br>F2=0.006$P_3^2$+5.5$P_2$+400Rs/hr.<br>F3=0.009$P_3^2$+5.8$P_2$+200Rs/hr.<br><br>Where P1,P2 and P3 in MW. Find the optimal dispatch and the total cost when the total load is 925MW with the following generator limits:<br>100MW<P1<450 MW<br>100MW<P2<350 MW<br>100MW<P3<225 MW | | | | direct method and λ-iteration method |
| 7 | Elucidate the various constraints in unit commitment problem | **16** | **4** | AN | statement of unit commitment problem |
| 8 | Explore the unit commitment problem using priority-list method. | **8** | **4** | AP | priority-list method |
| 9 | With a neat flowchart, explicate the forward dynamic programming method | **8** | **4** | AP | forward dynamic programming |
| 10 | Explore the unit commitment problem using forward dynamic programming. | **8** | **4** | AP | forward dynamic programming |

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**POWER SYSTEM OPERATION AND CONTROL**

**UNIT – V**
**COMPUTER CONTROL OF POWER SYSTEMS**

| S.No | Part – A | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | State the major functions that are carried out in an operation control center. | **2** | **5** | U | Need for computer control of power systems |
| 2 | Define energy control centre | **2** | **5** | AN | concept of energy control centre |
| 3 | State the fundamental design feature of energy control centre | **2** | **5** | AN | functions |
| 4 | State the function of system monitoring. | **2** | **5** | AN | system monitoring |
| 5 | Mention the sensors used in power system applications. | **2** | **5** | U | data acquisition and control |
| 6 | State the use of ADC in data acquisition and control | **2** | **5** | R | system hardware configuration |
| 7 | Mention the function of SCADA system. | **2** | **5** | U | SCADA and EMS functions |
| 8 | Define the EMS system. | **2** | **5** | U | SCADA and EMS functions |
| 9 | Write importance of state estimation in power system. | **2** | **5** | AN | state transition diagram. |
| 10 | List out the states of power system. | **2** | **5** | AP | state transition diagram. |

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| S.No | Part – B | Marks | CO | BTL | Topic in Syllabus |
|---|---|---|---|---|---|
| 1 | Explore the need of computer control of power system. | **16** | **5** | An | Need for computer control of power systems |
| 2 | With neat block diagram, explicate the overview of energy control centre. | **16** | **5** | An | concept of energy control centre |
| 3 | Explore the various functions of modern power system energy control centre. | **16** | **5** | An | functions |
| 4 | With neat block diagram, explicate energy control centre system monitoring. | **16** | **5** | An | system monitoring |
| 5 | With neat block diagram, explicate energy control centre data acquisition and control. | **8** | **5** | U | data acquisition and control |
| 6 | With neat block diagram, explicate SCADA hardware configuration. | **8** | **5** | AN | system hardware configuration |
| 7 | Explain the EMS system and functions with a neat diagram. | **8** | **5** | AN | SCADA and EMS functions |
| 8 | Elucidate various functions of SCADA with appropriate sketch. | **8** | **5** | AP | SCADA and EMS functions |
| 9 | Explicate various state transitions and control strategies using state transition diagram. | **16** | **5** | AP | State transition diagram. |
| 10 | Explore the security monitoring using state estimation with necessary diagram. | **16** | **5** | AP | State transition diagram. |

**STAFF INCHARGE** **DEAN/EEE** **PRINCIPAL**