**QUESTION BANK**

**SUBJECT: EE6005-Power Quality**

**SEM / YEAR: VII SEMESTER / ACADEMIC YEAR 2018-2019**

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| **UNIT I - INTRODUCTION TO POWER QUALITY** |
| Terms and definitions: Overloading - under voltage - over voltage. Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption. Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve. |
| **PART - A** |
| **Q.No** | **Questions** | **BT Level** | **Competence** |
| 1. | Define voltage swell | **1** | **Remember** |
| 2. | List the major power quality issue | **1** | **Remember** |
| 3. | Define voltage sag | **1** | **Remember** |
| 4. | Define the power quality as per IEEE | **1** | **Remember** |
| 5. | What are the main components of power quality | **1** | **Remember** |
| 6. | Define momentary interruption and components of waveform distortion | **1** | **Remember** |
| 7. | Comment” harmonics affect the electrical system” | **2** | **Understand** |
| 8. | Differentiate inter harmonic and sub harmonics | **2** | **Understand** |
| 9. | Illustrate about notching in power quality | **2** | **Understand** |
| 10. | Differentiate between voltage sag and voltage swell | **2** | **Understand** |
| 11. | Classify the types of power quality solutions available onthe market today | **3** | **Apply** |
| 12. | How are the power quality problems detected? | **2** | **Understand** |
| 13. | Find the harmonic distortion of a voltage waveform with following harmonic frequency make up: fundamental=114V, 3rd harmonic=4V, 5th harmonic=27V, 7th harmonic=1.5V and 9th harmonic=1V | **3** | **Apply** |

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| 14. | List out the need of power quality standards | **4** | **Analyze** |
| 15. | Comment transients or noise on the power line causing problems now | **4** | **Analyze** |
| 16. | What are the reasons voltage imbalance | **4** | **Analyze** |
| 17. | Criticize “capacitor switching leads to overvoltage” | **5** | **Evaluate** |
| 18. | Distinguish sag and swell | **5** | **Evaluate** |
| 19. | What do you mean by power frequency variations inpower quality | **6** | **Create** |
| 20. | Plot the CBEMA curve | **6** | **Create** |
| **PART – B** |
| 1. | 1. Name and explain different types of power quality issues that affects the power systems depending upon the severity? (6)
2. Define Total Harmonic Distortion. Explain the procedure for calculation the Total Harmonic Distortion(THD) due to disturbance in the power system

(7) | **1****1** | **Remember****Remember** |
| 2. | (i) Discuss the following characteristics of power quality issue (7)1. Short duration variations
2. Long duration variations

(ii)Discuss in detail about transients (6) | **1****1** | **Remember****Remember** |
| 3. | 1. Describe the CBEMA and ITI curve (7)
2. Define waveform distortion and explain the waveform distortion categories (6)
 | **1****1** | **Remember****Remember** |
| 4. | Write short notes on following power quality issues (13)1. Harmonics
2. Power frequency variations
 | **1** | **Remember** |
| 5. | Discuss the source and effects of different categories of long duration voltage variations that affect the powerquality (13) | **2** | **Understand** |
| 6. | Explain power quality and explain the reasons for increased concern in power quality (13) | **2** | **Understand** |

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| 7. | Discuss the following electrical power quality issue with examples (13)1. Voltage swell
2. Voltage interruption
 | **2** | **Understand** |
| 8. | Explain the various types of power quality disturbances in power system and also explain the characteristics of each disturbance (13) | **3** | **Apply** |
| 9. | (i)Summarize the impact of poor power quality on utility | **3** | **Apply** |
|  | and consumers (7) |  |  |
|  | (ii) Discriminate on over voltage and under voltage in power quality issue (6) | **3** | **Apply** |
| 10. | Formulate different categories and characteristics of power quality disturbance in power system network and point out which disturbance have most affect the powerquality (13) | **4** | **Analyze** |
| 11. | (i) Explain total harmonic distortion and total demand | **4** | **Analyze** |
|  | distortion (7) | **4** | **Analyze** |
|  | (ii)Discuss the standards of power quality (6) |  |  |
| 12. | 1. Demonstrate the major reasons for the growing concern about the quality of electric power by both electric utilities and end users (7)
2. Illustrate the principle phenomenon causing electric magnetic disturbance classified by International Electro technical commission (6)
 | **6****6** | **Create****Create** |
| 13. | With a waveform sketch, explain the terms (13) (a)Voltage sag(b)Voltage interruption (c)Voltage swells(d)Sag with harmonics | **5** | **Evaluate** |

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| 14. | (i)Discuss about the Computer Business Equipment Manufactures Associations(CBEMA) curve.Explain the events described in the curve. (7)ii)Differentiate between power quality, voltage quality and current quality (6) | **2****2** | **Understand****Understand** |
| **PART – C** |
| 1 | Explain the following electrical power quality issues in detail with examples1. Voltage Imbalance
2. Transient (15)
 | **4** | **Analyze** |
| 2 | Discuss in detail about transients and waveform distortion related to the power quality (15) | **5** | **Evaluate** |
| 3 | Explain briefly about international standard of power quality (15) | **4** | **Analyze** |
| 4 | Explain the various types of power quality disturbances(15) | **5** | **Evaluate** |

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| **UNIT II - VOLTAGE SAGS AND INTERRUPTIONS** |
| Sources of sags and interruptions - estimating voltage sag performance. Thevenin’s equivalent source- analysis and calculation of various faulted condition. Voltage sag due to induction motor starting. Estimation of the sag severity - mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches. |
| **PART – A** |
| **Q.No** | **Questions** | **BT Level** | **Competence** |
| 1. | When sag leads to interruption | **1** | **Remember** |
| 2. | List out the causes of sag | **1** | **Remember** |
| 3. | List out the three levels of possible solutions to voltage sag andmomentary interruption problems | **1** | **Remember** |
| 4. | List some industry standards associated with voltage sags | **1** | **Remember** |
| 5. | Name the sources of sags and interruption | **1** | **Remember** |
| 6. | Interpret the various factors affecting the sag magnitude due tofaults at a certain point in the | **2** | **Understand** |
| 7. | What are the causes of short interruption | **2** | **Understand** |
| 8. | Classify different types of voltage sag | **3** | **Apply** |
| 9. | Name the different motor starting methods. | **2** | **Understand** |
| 10. | Differentiate voltage swell and voltage transients | **2** | **Understand** |
| 11. | How to estimate voltage sag performance | **1** | **Remember** |
| 12. | Describe the importance of voltage sag estimation | **2** | **Understand** |
| 13. | Demonstrate how voltage sag can be mitigated and list the typesto mitigation devices | **3** | **Apply** |
| 14. | Demonstrate the causes for voltage sags due to transformer energizing | **3** | **Apply** |
| 15. | Define active series compensator | **4** | **Analyze** |
| 16. | Explain static transfer switch | **5** | **Evaluate** |
| 17. | Design the active low pass filter to mitigate the voltage swell | **6** | **Create** |
| 18. | Summarize the main function of DSTATCOM | **5** | **Evaluate** |
| 19. | What are the main functions of DVR? | **4** | **Analyze** |
| 20. | Compose the active series compensator in voltage sag | **6** | **Create** |
| **PART – B** |
| 1. | 1. Explain the sources of sags in power system (7)
2. Discuss the sources of interruption to affect the power quality

(6) | **1****1** | **Remember Remember** |

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| 2. | 1. Describe in detail about the sag performance evaluation indices.

(7)1. Describe the methodology of estimating voltage sag performance (6)
 | **1****1** | **Remember Remember** |
| 3. | Explain the following causes of sag (13) a)Voltage sag to motor1. Voltage sag due to single line to line fault
2. Voltage sag due to single line to ground fault
 | **3** | **Apply** |
| 4. | 1. Explain various indexes used to estimate voltage sag (7)
2. Discuss some of the solutions for voltage sag and interruption

(6) | **2****2** | **Understand****Understand** |
| 5. | What is the need for estimating sag performance Explain the different methods of estimating voltage sag Performance (13) | **2** | **Understand** |
| 6. | Analysis and calculation of power quality due various faulted condition (13) | **2** | **Understand** |
| 7. | 1. Explain performance voltage sag due to starting of large induction motor in distribution level (7)
2. How does the load influence on voltage sag adjustable speed drives? (6)
 | **4****6** | **Analyze Create** |
| 8. | Explain the operation of Distribution Static Compensator (DSTATCOM) used for sag mitigation (13) | **4** | **Analyze** |
| 9. | Analyse the different methods for estimating voltage sag severity due to the disturbance in the power system (13) | **5** | **Evaluate** |
| 10. | 1. Explain active series compensator to compensate the voltage sag occurs in power system (7)
2. Explain how ferro resonance transformer to improve the voltage sag performance (6)
 | **3****3** | **Apply****Apply** |
| 11. | 1. Explain the solid state transfer switch with transfer operation

(7)1. Explain fast transfer switch with transfer operation (6)
 | **3****3** | **Apply****Apply** |

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| 12. | 1. What are the different voltage sag mitigation techniques?

Explain the principle of operation of DVR used for sag mitigation (7)1. Analyze about estimating the cost of voltage sag events in the power system (6)
 | **6****1** | **Create****Remember** |
| 13. | Explain any two voltage sag mitigation Techniques with necessary circuit diagram and waveform (13) | **4** | **Analyze** |
| 14. | Explain the role of compensators in mitigation of voltage sags.(13) | **5** | **Evaluate** |
| **PART – C** |
| 1 | Describe the procedure for estimating motor switching voltage sag (15) | **5** | **Evaluate** |
| 2 | Discuss the effects of voltage sag and interruption on various electrical equipment (15) | **4** | **Analyze** |
| 3 | What are the different voltage sag mitigation sag techniques? Explain in detail (15) | **5** | **Evaluate** |
| 4 | Briefly explain static transfer switches and fast transfer switches(15) | **4** | **Analyze** |

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| **UNIT III - OVERVOLTAGES** |
| Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners. Lightning protection – shielding – line arresters - protection of transformers and cables. An introduction to computer analysis tools for transients, PSCAD and EMTP. |
| **PART – A** |
| **Q.No** | **Questions** | **BT Level** | **Competence** |
| 1. | What is transient overvoltage? | **1** | **Remember** |
| 2. | Define Ferro resonance | **1** | **Remember** |
| 3. | Define lightning phenomena | **1** | **Remember** |
| 4. | What is the significance of EMTP studies | **2** | **Understand** |
| 5. | Write the need for power conditioners | **2** | **Understand** |
| 6. | List the sources of over voltage | **1** | **Remember** |
| 7. | Demonstrate the working principle of surge arrestor? | **3** | **Apply** |
| 8. | When does Ferro resonance occur in a power system? | **1** | **Remember** |
| 9. | Summarize the devices used for protection of over voltages? | **2** | **Understand** |
| 10. | Show the causes for oscillatory voltage transients? | **3** | **Apply** |
| 11. | Define impulsive transients and predict suitable examples | **2** | **Understand** |
| 12. | Analyze the protection methods of cable against over voltages | **4** | **Analyze** |
| 13. | Show the various causes of over voltages? | **3** | **Apply** |
| 14. | Define voltage magnification. | **1** | **Remember** |
| 15. | Prepare the common ways for the utility to protect the transformer | **6** | **Create** |
| 16. | Analyze how does lightning cause over voltages? | **4** | **Analyze** |
| 17. | Predict the functions of line arrestors | **5** | **Evaluate** |
| 18. | Compare the difference between Transient Voltage SurgeSuppressors (TVSS) and surge arrestors. | **5** | **Evaluate** |
| 19. | What do you mean by capacitor switching | **4** | **Analyze** |
| 20. | Why low-pass filter used in transient protection | **6** | **Create** |
| **PART - B** |
| 1. | Analyze the source of transient over voltages in power systems.(13) | **4** | **Analyze** |

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| 2. | Write short notes on the following:1. Low pass filters (7)
2. Power conditioner (6)
 | **2****2** | **Understand****Understand** |
| 3. | (i) Explain the problems associated with Ferro resonance. (7) (ii)What are the different sources of transient over voltages? Discuss the capacitor switching transient. (6) | **4****1** | **Analyze Remember** |
| 4. | 1. Explain the underground cable system protection. (7)
2. Explain in detail about the protection of transformer (6)
 | **4****4** | **Analyze Analyze** |
| 5. | Write short notes on the following1. Lightning arrestor (7)
2. Line arrestor (6)
 | **2****2** | **Understand****Understand** |
| 6. | Illustrate the phenomena of impulsive transients and oscillatory transients (13) | **3** | **Apply** |
| 7. | Discuss the source of overvoltage due to following phenomena.1. Capacitor switching. (7)
2. Magnification of Capacitor switching transients (6)
 | **2****2** | **Understand Understand** |
| 8. | List the fundamental principles of overvoltage protection of load equipment. (13) | **1** | **Remember** |
| 9. | 1. Explain in detail about the surge arrestors and surge suppressors for over voltage protection. (7)
2. What are the advantages of surge arrestors? Discuss about the application module (6)
 | **4****1** | **Analyze****Remember** |
| 10. | .(i) What are the various lightning protection schemes used for over voltage lines? (7)(ii) Evaluate the use of PSCAD in analyzing the power quality. Integrate them. (6) | **6****5** | **Create****Evaluate** |
| 11. | Describe the sources of transient over voltages in high, medium and low frequency range. (13) | **1** | **Remember** |
| 12. | Describe different methods of protection of transformers and cables against voltage transients. (13) | **1** | **Remember** |

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| 13. | 1. Describe the following mitigation technique of over voltages with diagrams
	1. Shielding
	2. Cable Protection (10)
2. Explain the “Ferro Resonance” in detail. (3)
 | **3****5** | **Apply****Evaluate** |
| 14. | 1. Define lightning. Discuss in detail about the over voltages due to lightning and the problems associated with it. (7)
2. What are the advantages of computer analysis tools? Generalize about PSCAD and EMTP for transient studies? (6)
 | **3****6** | **Apply****Create** |
| **PART-C** |
| 1 | What are the various lightning protection scheme used for over voltage protection under the presence of harmonics (15) | **4** | **Analyze** |
| 2 | Briefly explain about shielding and surge arrestor (15) | **5** | **Evaluate** |
| 3 | Explain in detail over voltages produced due to Ferro resonance(15) | **4** | **Analyze** |
| 4 | Explain in detail about various methods to mitigate voltage swells(15) | **5** | **Evaluate** |

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| **UNIT IV- HARMONICS** |
| Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices - inter harmonics – resonance. Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters.IEEE and IEC standards. |
| **PART - A** |
| **Q.No** | **Questions** | **BT Level** | **Competence** |
| 1. | State the different between harmonics and transients | **3** | **Apply** |
| 2. | Define point of common coupling (PCC). | **1** | **Remember** |
| 3. | Mention the harmonic effects on devices and loads. | **2** | **Understand** |
| 4. | Analyze the objectives of IEEE and IEC standards? | **5** |  |
| 5. | Why even harmonics are normally absent in the power converters? | **3** | **Apply** |
| 6. | Define harmonics. | **1** | **Remember** |
| 7. | Interpret about Total Demand Distortion (TDD)? | **2** | **Understand** |
| 8. | What are the various effects on devices and loads | **3** | **Apply** |
| 9. | Define Total harmonic distortion | **1** | **Remember** |
| 10. | Summarize the advantage of three phase converter | **5** | **Evaluate** |
| 11. | Write the need of locating harmonic sources | **1** | **Remember** |
| 12. | Point out the sources of harmonics from industrial loads | **4** | **Analyze** |
| 13. | Distinguish between active filter and passive filter. | **2** | **Understand** |
| 14. | Differentiate between linear loads and nonlinear loads | **2** | **Understand** |
| 15. | Compose the difference between harmonics and inter harmonics | **6** | **Create** |
| 16. | Infer voltage and current distortion? | **4** | **Analyze** |
| 17. | What are the applications of active filters? | **4** | **Analyze** |
| 18. | What is the significance of power quality indices | **1** | **Remember** |
| 19. | Prepare the distortion | IEEE | harmonic | standard | on | harmonic | **6** | **Create** |
| 20. | Name the devices for controlling harmonic distortion | **1** | **Remember** |

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| **PART - B** |
| 1. | Explain the methods to evaluate harmonic distortion and devices to control (13) | **4** | **Analyze** |
| 2. | 1. Explain the IEEE and IEC standards on harmonics distortion. (7)
2. What are the filters in harmonic analysis? Explain active and passive filters (6)
 | **3****3** | **Apply****Apply** |
| 3. | (i) Explain briefly how the phenomena of current | **4** | **Analyze** |
|  | distortion affects the voltage distortion under the |  |  |
|  | presence of harmonics (7) |  |  |
|  | (ii) Explain briefly about locating harmonic sources and | **4** | **Analyze** |
|  | characterization in power system (6) |  |  |
| 4. | (i) Explain the power system response characteristics | **4** | **Analyze** |
|  | under the presence of harmonics. (7) |  |  |
|  | (ii)What is the need of IEEE standards used in harmonics studies? Give their philosophy and objectives of these | **1** | **Remember** |
|  | standards (6) |  |  |
| 5. | 1. Explain the fundamentals of harmonics generation and waveform distortion. (7)
2. Prepare the following terms
	1. Current distortion
	2. Voltage distortion (6)
 | **4** | **Analyze** |
|  | **4** | **Analyze** |
| 6. | Discuss the effects of harmonics on electrical power components (13) | **2** | **Understand** |
| 7. | Write short note on the active filter and passive filter in controlling harmonic distortion (13) | **1** | **Remember** |
| 8. | Explain how commercial and industrial loads are responsible for harmonic distortion. (13) | **5** | **Evaluate** |

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| 9. | Determine the RMS and THD of the following waveform | (13) | **3** | **Apply** |
| 10. | Discuss the characteristics of harmonics generated by different types of industrial load and commercial load(13) | **1** | **Remember** |
| 11. | 1. Explain the waveform distortion due to different types of nonlinear loads (7)
2. Write short notes on the following
	1. Harmonic indices
	2. Inter harmonics (6)
 | **4** | **Analyze** |
|  | **2** | **Understand** |
| 12. | (i) Write short notes on THD and TDD. | (3) | **2** | **Understand** |
|  | (ii)Discuss the effects of harmonic distortion on transformers and motors. | (10) | **2** | **Understand** |
| 13. | .(i) What is meant by point of common coupling? | **1** | **Remember** |
|  | Generalize the IEEE 519 standard and IEC 61000-3-2 |  |  |
|  | standard with respect to harmonics. | (7) |  |  |
|  | (ii)Design the detail operation of shunt active filter. (6) | **6** | **Create** |
| 14. | .(i) Demonstrate about evaluation of harmonic distortion(7)1. Define the following terms related with IEEE standards . (6)
	1. SCR
	2. Total harmonic distortion.
 | **3** | **Apply** |
|  | **1** | **Remember** |
| **PART-C** |
| 1. | What are the devices used for controlling harmonic distortion and explain their function (15) | **5** | **Evaluate** |
| 2. | Explain briefly about harmonic distortion and conduct an evaluation of study (15) | **4** | **Analyze** |



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| 3. | Explain briefly about the phenomena of how current distortion affects the voltage distortion under the presence of harmonics (15) | **6** | **Create** |
| 4. | Explain the function of active filters and how it overcomes the drawbacks of passive filter in controlling harmonic (15) | **5** | **Evaluate** |

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| **UNIT V - POWER QUALITY MONITORING** |
| Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modelling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer – quality measurement equipment - harmonic / spectrum analyzer - flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring. |
| **PART - A** |
| **Q.No** | **Questions** | **BT Level** | **Competence** |
| 1. | What is the role of expert system in power quality studies | **1** | **Remember** |
| 2. | Define power quality monitoring | **1** | **Remember** |
| 3. | Interpret the merits of modelling and simulation? | **2** | **Understand** |
| 4. | Prepare the online power quality monitoring merits? | **6** | **Create** |
| 5. | What is flicker meter? | **1** | **Remember** |
| 6. | Describe about signal processing tools for analyzing power quality issues | **2** | **Understand** |
| 7. | Interpret the benefits of power quality monitoring? | **2** | **Understand** |
| 8. | List some of the major power quality monitoring equipment. | **1** | **Remember** |
| 9. | State and analyze the objectives of power quality monitoring | **3** | **Apply** |
| 10. | List out the various power quality monitoring steps | **5** | **Evaluate** |
| 11. | Analyze the merits of digital power quality analyzers? | **4** | **Analyze** |
| 12. | Conclude the steps involved in power quality monitoring? | **5** | **Evaluate** |
| 13. | Mention any two signal processing tools for analyzing power quality issues | **3** | **Apply** |
| 14. | Estimate the importance of power quality monitoring? | **2** | **Understand** |
| 15. | What is spectrum analyzer? | **4** | **Analyze** |
| 16. | Name the factors of selecting the instrument for power quality monitoring | **1** | **Remember** |
| 17. | Infer the power quality disturbance analyzer. | **4** | **Analyze** |
| 18. | List the difference between offline and online power quality data assessment | **1** | **Remember** |
| 19. | What is meant by proactive monitoring | **1** | **Remember** |
| 20. | Write any two IEEE standards to assess the power quality monitoring | **6** | **Create** |

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| **PART - B** |
| 1. | Discuss the power quality monitoring considerations in details. (13) | **2** | **Understand** |
| 2. | Explain the flicker meter and flicker measurement techniques in details. (13) | **3** | **Apply** |
| 3. | Explain in detail with necessary diagram the working principle and functioning of power quality analyzers(13) | **5** | **Evaluate** |
| 4. | Briefly discuss the common objectives of power quality monitoring. (13) | **2** | **Understand** |
| 5. | 1. Bring out the important characteristics of power quality variations. (7)
2. Explain the steps involved in power quality monitoring. What are the information from monitoring site surveys? (6)
 | **2****1** | **Understand****Remember** |
| 6. | 1. Explain the various instruments used for power quality measurements. (7)
2. What are the factors to be considered when selecting the instruments? (6)
 | **1****1** | **Remember****Remember** |
| 7. | Illustrate the importance of power line analyzer. (13) | **3** | **Apply** |
| 8. | Explain the features of spectrum analyzer and flicker meters(13) | **4** | **Analyze** |
| 9. | Describe the modelling of power quality problems by mathematical solution tools. (13) | **1** | **Remember** |
| 10. | Write short note on the following1. Disturbance analyzer
2. Flicker meter (13)
 | **2** | **Understand** |
| 11. | 1. Analyze the role and application of expert systems in power quality monitoring (7)
2. Discuss briefly about the different features of harmonic analyzer (6)
 | **4****2** | **Analyze****Understand** |
| 12. | (i) Explain in detail about the flicker meter (7) (ii)Design and explain about power quality disturbanceanalyzer (6) | **4****4** | **Analyze****Analyze** |
| 13. | Design the block diagram of advanced power quality monitoring systems. Explain it in detail. (13) | **6** | **Create** |

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| 14. | .(i) Bring the significance of power quality maintaining? Demonstrate the objectives of power quality maintaining?(7)(ii) Write short notes on power quality measurement system. What are the characteristics of power quality measurement equipments? (6) | **3****1** | **Apply****Remember** |
| **PART-C** |
| 1 | Explain monitoring requirement of different types of power quality variation (15) | **4** | **Analyze** |
| **2** | Discuss in detail about expert system for power quality monitoring (15) | **5** | **Evaluate** |
| **3** | Explain the steps involved in power quality monitoring.What are the information from monitoring site surveys(15) | **5** | **Evaluate** |
| **4** | Illustrate the features of power quality monitoring and assessment (15) | **4** | **Analyze** |