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| **Name:**<br>**Enrolment No:** | UPES<br>UNIVERSITY WITH A PURPOSE |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, May 2019**

**Course: Electrical System Safety and It's Design** **Semester: IV**
**Program: B. Tech-FSE** **Time :03 hrs.**
**Course Code: HSFS 2006** **Max. Marks: 100**

**Instructions:**

**SECTION A**

| **S. No.** | **Answer all the questions** | **20 Marks** | **Mapped CO** |
|---|---|---|---|
| **Q 1** | Define "Electrical Fault". Brief about types of faults and comment on their risk level. | **1+3** | **CO2** |
| **Q 2** | Expand the following:<br>a. HECP<br>b. MESG<br>c. IP (rating)<br>d. GFCI | **4** | **CO1-CO4** |
| **Q 3** | Define 'Arc Flash'. List and brief the causes and consequences of same. | **1+3** | **CO2** |
| **Q 4** | Brief about: "variation of bio-impedance with path and physical condition". | **4** | **CO 1** |
| **Q 5** | State the causes and consequences of static accumulation. | **4** | **CO 4** |

**SECTION B**

| **S. No** | **Answer all the questions** | **40 Marks** | **Mapped CO** |
|---|---|---|---|
| **Q 6** | Discuss about 'Arc Flash Protection Boundaries' with necessary sketches and associated PPEs. | **8+2** | **CO 1** |
| **Q 7** | Discuss various types of 'Neutral Grounding' schemes with necessary sketches along with applications and limitations of each. | **8 +2** | **CO 3** |
| **Q 8** | Define 'Fuse'. Discuss the types of fuses used in LV applications with necessary sketches along with advantages and disadvantages of same. | **2+ 6+2** | **CO 3** |
| **Q 9** | Expand AFHA. Elucidate the NESC's methodology of AFHA along with applications and limitations.<br>(Or)<br>Explain the prevention and protection measures to be taken against electric shock. | **1+7+ 2**<br><br>**10** | **CO 1 & CO2** |

**SECTION-C**

| **S. No** | **Answer all the questions** | **40 Marks** | **Mapped CO** |
|---|---|---|---|
| Q 10 | Calculate the 3 Phase fault level for the following case: A generator connected to a transformer, which is connected to transmission line serving an induction motor. Fault occurred at midpoint of line. Consider generator values as reference.<br>The positive sequence reactance's are as given below.<br>Generator: $X_{g\,=}$ 0.1 p.u , EMF- 1.0 P.U on 10KV, 1 MVA<br>Transformer: $X_T$ = 0.09 p.u on 11KV/415V, 2 MVA<br>Tr. Line: 1ohms, 415V | **20** | **CO 2** |

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|---|---|---|---|
| | **Induction Motor** 415V, 5 HP, Reactance- 0.4 P.U | | |
| Q 11 | Read the case study carefully and answer the questions following:<br>Minor faults may sometimes cause devastating results!<br>A new plant was built with the economic and ecological purposes of recycling polluted toluene instead of disposing it in an incineration. As it often happens with larger projects, not all parts of the plant were completed in time. In this case, the piping toward the recycling station of the polluted toluene was not finally installed.<br>This meant that the polluted toluene, which was stored in a collecting tank on the ground floor, had to be disposed of by pumping it into metal drums. Lorries then transported the full drums to the recycling station and returned them empty. A worker was engaged to fill the polluted toluene into steel drums and was also responsible to avoid overfilling the collecting tank, because any overflow would automatically shut down the entire process. The management was well aware of the danger emanating from this temporary makeshift accommodation and had taken relevant measures against electrostatics:<br>An earthed pump was installed to convey the toluene into the steel drum via a dissipative hosepipe. To make sure that the electrostatic charge of the steel drum was always reliably dissipated, an earthed steel grating was provided, especially as a place to rest the drum to be filled. The surrounding flooring was dissipative, and the worker was wearing dissipative shoes.<br>So, it seemed that by these preventive measures the possibility of spark discharges from the worker or the metal drum were eliminated. But the disaster ran its course when during a nightshift the lorry returning the empty drums had an engine failure and this started a chain of events whereby finally the mess was initiated.<br>The worker was informed that another lorry had to be ordered, most likely causing delay in drum transportation. In the course of time, the operator found himself in the situation that he had filled all available metal drums and the collecting tank was almost full. To avoid the accusation that he had brought the whole system to a standstill by his unreadiness, he in despair searched for another drum and, finally, found one. But this drum was made of polyethylene instead of steel, but for want of better knowledge about dangerous electrostatic charges this gave him no cause of concern.<br>He used it without being aware or caring that insulating materials can present an electrostatic hazard in that situation. The hosepipe was hung inside the plastic drum and the pump switched on. Shortly afterward, a jet of flame shot out of the drum. The worker found a way and immediately ran for a water hosepipe and tried to extinguish the fire by pouring water into the drum. But the expected extinguishing effect failed to appear, it came much worse:<br>The water displaced the burning toluene over the rim of the drum causing a spread of the flames. The unfortunate man understood that his extinguishing efforts had failed.<br>He then gave up his own fire-fighting efforts and ran off to call the fire brigade without switching off the pump! Because of the steady flow of toluene, the fire spread to the nearby full drums, which also caught fire. Now the eager worker took only right moves in this terrible situation: He ran out of the building, getting to safety before the heated-up drums burst open and kindled a huge blaze. Even the advancing fire brigade was so impressed by the force majeure of the fire that they did not try to extinguish the blaze but concentrated on protecting the surrounding buildings.<br>a. Find out the root cause of incident. Discuss the system as well human contribution in occurrence of the catastrophe.<br>b. If you're in this situation, discuss how could you have avoided the catastrophe. | **10+ 10** | **CO4** |
| | (OR)<br>An electrical equipment has the following things on its name plate: "Ex $i_a$ IIC T1 Z-0 IP 650". Name and explain the details of terms mentioned above. | **20** | **CO 5** |

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**Instructions:**

**SECTION A**

| S. No. | Answer all the questions | 20 Marks | Mapped CO |
|---|---|---|---|
| Q 1 | Define "P.U. Value". Brief significance of the same. | 1+3 | CO2 |
| Q 2 | Expand the following:<br>a. MIC Ratio<br>b. MCB<br>c. IP (Code/Standard)<br>d. RCD | 4 | CO1-CO4 |
| Q 3 | Define 'Arc Blast'. Differentiate the same from 'Flash' and 'Spark' | 2+2 | CO2 |
| Q 4 | Brief about: "variation of bio-impedance with path and physical condition". | 4 | CO 1 |
| Q 5 | State the causes and consequences of 'Electric Shock'. | 4 | CO 1 |

**SECTION B**

| S. No | Answer all the questions | 40 Marks | Mapped CO |
|---|---|---|---|
| Q 6 | **It is necessary to maintain a safe distance from an energized equipment, else may cause severe arc flashes**. Discuss about the linear distances to be maintained around an electrically live equipment to avoid arc flashes, with necessary sketches and quote the code of reference, along with suitable personal protection gear. | 5+4+1 | CO 1 |
| Q 7 | Discuss how the static accumulation and ESDs can be prevented and/or mitigated. | 10 | CO 4 |
| Q 8 | Define 'Fuse'. Discuss the types of fuses used in HV applications with necessary sketches along with advantages and disadvantages of same. | 2+ 6+2 | CO 3 |
| Q 9 | Expand and define LOTO. Explain when it should be applied and give the steps involved in LOTO'ing of a machine.<br>(Or)<br>Define "Symmetrical Fault". Discuss the procedure of symmetrical fault calculation along with assumptions/constraints made there under. | 2+2+6<br><br>10 | CO 1 & CO2 |

**SECTION-C**

| S. No | Answer all the questions | 40 Marks | Mapped CO |
|---|---|---|---|
| Q 10 | Calculate the 3 Phase fault level for the following case: A generator connected to a transformer, which is connected to transmission line serving a synchronous motor. Fault occurred at input terminals of motor. Consider generator values as reference.<br>The positive sequence reactance's are as given below.<br>Generator: $X_{g}$ = 0.1 p.u , EMF- 1.0 P.U on 10KV, 1 MVA | | CO 2 |

| | | | |
|---|---|---|---|
| | Transformer: $X_T$ = 0.09 p.u on 11KV/415V, 2 MVA<br>Tr. Line: 10ohms, 415V, **Synchronous Motor** 415V, 10 HP, Reactance- 0.4 P.U , efficiency – 90%, p.f-0.9 lag | | |
| Q 11 | Discuss various types of protective devices that protect human operator from electrical hazards along with applications and limitations.<br>(OR)<br>Define 'Hazardous Area'. Explain all components of the HAC'ing as per both NEC and IEC. | **10+ 10**<br><br>**2 + 9+ 9** | **CO 3**<br><br>**CO5** |