2014-15  
M.TECH. (WINTER SEMESTER) EXAMINATION  
ELECTRICAL ENGINEERING  
ADVANCED ELECTRIC DRIVES - I  
EE 611  

Maximum Marks: 60  
Credits: 04  
Duration: Three Hours  

Answer ANY FIVE questions.  
Assume suitable data if missing.  
Notations used have their usual meaning.  

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
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<tbody>
<tr>
<td>1(a)</td>
<td>How can regenerative braking operation be achieved in a separately excited dc motor fed by a fully controlled rectifier?</td>
<td>[03]</td>
</tr>
<tr>
<td>1(b)</td>
<td>A 2.2 kW, 220 V, 11.6 A, 1500 rpm dc separately excited motor has the armature resistance and inductance of 2 Ω and 32.5 mH, respectively. This motor is controlled by a chopper with a frequency of 500 Hz and the input voltage of 220 V. The motor is driving the load whose torque is proportional to the speed. At a duty ratio (D) = 0.9 the motor runs at 1260 rpm. What will be the value of D and the current ripple at 800 rpm?</td>
<td>[06]</td>
</tr>
<tr>
<td>1(c)</td>
<td>Why dc shunt motor is not used in solar photovoltaic dc drives?</td>
<td>[03]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Consider a separately excited dc motor which is being fed from a single-phase fully-controlled rectifier. Derive the relation for its torque speed characteristics when it is operating in mode II (a discontinuous conduction mode). Also give the circuit diagram and show the waveforms of armature voltage and armature current for this mode of operation. Mention the conditions to be satisfied for operation in this mode.</td>
<td>[08]</td>
</tr>
</tbody>
</table>
| 2(b)  | A 10 kW, 440 V, 60 Hz, 4 pole, Y-connected permanent magnet synchronous motor has following parameters:  

\[ X_m = 15 \, \Omega, \, X_s = 1 \, \Omega, \, \text{negligible} R_s, \, \text{Rated power factor} = 0.85 \, \text{(lagging)} \]  

Calculate: (i) The equivalent field current \( I_f' \) and pull-out torque. (ii) The torque angle at | [04] |
full load. (iii) The power factor and the armature current at 60 percent of the rated torque. (iv) The torque when operating at unity power factor. (v) If this motor is operated in regenerative braking mode, then calculate the armature current and power factor at the rated braking torque.

Neglect friction, windage and core loss.

| 3(a) | Two dc series motors with different air gaps but otherwise identical run at 700 and 750 rpm, respectively, when they take 50 A from 500 V supply. The total resistance of each motor is 0.36 Ω. If the motors are now mechanically coupled and connected in series electrically to a 500 V dc supply and together takes 50 A, then calculate the speed at which the couple will run. |
| 3(b) | A separately excited dc motor is controlled by chopper using CLC-principle. Draw the equivalent circuits for different intervals and derive the expressions for respective current in steady-state. Also derive the expression for duty ratio and time period at steady state in terms of the predetermined two values of armature currents |
| 4(a) | A 220 V, 1500 rpm, 11.6 A separately excited dc motor has the armature resistance and inductance of 2 Ω and 28.36 mH, respectively. This motor is controlled by a 1-phase fully-controlled rectifier with an ac source voltage of 230 V, 50 Hz. Identify the modes for the following:

(i) \( \alpha = 30^0 \) and speed = 1480 rpm

(ii) \( \alpha = 30^0 \) and speed = 1000 rpm.

Find the torque for continuous conduction mode out of the above (if any). |
| 4(b) | Derive the transfer function of a separately excited dc motor with armature voltage control. From this show that \( \frac{I_a(s)}{V_a(s)} \) can be approximated with a first order transfer function. How one can find \( \frac{\Omega_a(s)}{V_a(s)} \) from \( \frac{I_a(s)}{V_a(s)} \). |
| 5(a) | A separately excited dc motor is fed from a three-phase fully-controlled rectifier for its |

Contd....3.
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<tr>
<td>5(b)</td>
<td>Derive the equivalent circuit of synchronous motor from its basic principle of operation. Also give the relevant phasor diagram.</td>
</tr>
<tr>
<td>6(a)</td>
<td>Describe the self-control operation of synchronous motor drive.</td>
</tr>
<tr>
<td>6(b)</td>
<td>With the help of neat circuit diagram and waveforms of gating signals, voltage and current explain the Pulse-Width Modulated-operation of a separately excited dc motor fed from a single-phase converter.</td>
</tr>
<tr>
<td>6(c)</td>
<td>A 2.2 kW, 220 V, 11.6 A, 1500 rpm separately excited dc motor has an armature resistance and inductance of 2 Ω and 32.5 mH, respectively. This motor is controlled by a chopper of frequency 500 Hz and the input voltage of 220 V. The motor is driving a load whose torque is proportional to the speed. At duty ratio (D) = 0.9 the motor runs at 1260 rpm. What will be the value of D and the current ripple at 800 rpm?</td>
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<tr>
<td>7(a)</td>
<td>With the help of (i – v) and (p – v) characteristics of a solar cell explain its maximum power point operation. Discuss the different options of motors for water pumping application of PV array. What are the various possibilities for its operation with DC and AC motors? Explain them giving the relevant circuit diagram or block diagram.</td>
</tr>
<tr>
<td>7(b)</td>
<td>Describe different types of synchronous motors used in drives applications. With reference to the control of synchronous motor, differentiate between self-control and load commutated control schemes.</td>
</tr>
</tbody>
</table>
## Question Paper

### M.TECH. (WINTER SEMESTER) EXAMINATION
### ELECTRICAL ENGINEERING
### (POWER SYSTEM AND DRIVES)
### ADVANCE ELECTRIC DRIVES II
### EE-612

**Maximum Marks: 60**

**Credits: 04**

**Duration: Three Hours**

*Answer any FIVE questions.*

*Assume suitable value for missing data if any.*

*Notations used have their usual meaning.*

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<tr>
<td>1(a)</td>
<td>What are the special requirements of Adjustable Speed High Performance Drives?</td>
<td>[03]</td>
</tr>
<tr>
<td>(b)</td>
<td>What are special features of Induction Motor drives in general?</td>
<td>[03]</td>
</tr>
<tr>
<td>(c)</td>
<td>A wound rotor induction motor is running at rated speed. It is to be braked to zero speed using plugging braking. Describe the whole operation, step wise with the help of speed – torque characteristics and equivalent circuit.</td>
<td>[06]</td>
</tr>
<tr>
<td>2(a)</td>
<td>With the help of block diagram explain the working of a closed loop; CSI fed variable frequency drive with current control. How is the flux maintained as constant in this scheme?</td>
<td>[06]</td>
</tr>
</tbody>
</table>
| (b)   | A 3-ph, 400 V, 50 Hz, 6 pole, 10 kW, 960 rpm, star connected, wound rotor Induction Motor has the following parameters: \[ R_s = 0.4 \, \Omega, \, R_r = 0.6 \, \Omega, \, X_{ls} = X_{lr} = 2 \, \Omega \]  
  The stator to rotor turn ratio is 2.5  
  The speed at full load torque is reduced to 500 rpm by injecting a voltage into the slip rings. Calculate the magnitude and frequency of the injected voltage. Assume the injected voltage is in phase with V. | [06] |
| 3     | A 400 V, 50 Hz, 4-pole, 1485 rpm, Y-connected sq. cage induction motor has the following parameters for the exact equivalent circuit: \[ R_s = 0.03 \, \Omega, \, X_s = 0.32 \, \Omega, \, X_m = 7 \, \Omega, \, R_r = 0.024 \, \Omega, \, X_r = 0.48 \, \Omega \]  
  The motor is fed from a current source inverter, which in turn is fed from a chopper with a dc link voltage of 600 V. The dc link inductor has a resistance of 0.001 \, \Omega.  
  The motor is operated at constant flux of rated value. Calculate the duty ratio of | [12] |

*cont'd... 2*
chopper for rated motor torque and a speed of 1000 rpm.

<table>
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<tr>
<th>4</th>
<th>Draw a labelled circuit diagram of a static rotor resistance controlled drive. Derive its equivalent circuit. Establish the mathematical expression for torque and draw its speed-torque characteristics. Highlight the salient feature of its performances.</th>
<th>[12]</th>
</tr>
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<tr>
<td>5(a)</td>
<td>An induction motor is being fed from a six step voltage source inverter. Derive an equivalent circuit for $k^{th}$ harmonic component of stator current and find the relevant mathematical expression.</td>
<td>[08]</td>
</tr>
<tr>
<td>(b)</td>
<td>With neat diagram explain the working principle of Kramer's drive. Compare its performance with that of Scherbius drive.</td>
<td>[04]</td>
</tr>
<tr>
<td>6</td>
<td>Explain the transformation of variables from 3 phase stationary frame to 2 phase stationary frame and subsequently to 2 phase frame rotating at synchronous speed. Develop the Stanley dynamic model of an Induction motor and find the complex equivalent circuit based on this model. Comment on the order of the system.</td>
<td>[12]</td>
</tr>
<tr>
<td>7</td>
<td>Explain the basic principle of stator flux oriented vector control. What are the merits and demerits of this method? How are the coupling effects compensated to obtain decoupled control of flux and torque?</td>
<td>[12]</td>
</tr>
</tbody>
</table>
### 2014-2015

**M.TECH AUTUMN (I SEMESTER) EXAMINATION**  
**(ELECTRICAL ENGINEERING)**  
**(Power System & Drives)**  
**ADVANCE POWER ELECTRONICS**  
**(EE – 621)**  
*Credits: 04*

Maximum Marks: 60. 
Duration: Three Hours

**Answer any FIVE questions.**  
**Notations used have their usual meanings.**

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<tr>
<td>1.(a)</td>
<td>Describe various methods used for the reduction of harmonics in the output voltage of a voltage source inverter (VSI)</td>
<td>8</td>
</tr>
<tr>
<td>1.(b)</td>
<td>Explain the effects of Amplitude-Modulation Index ( M_a ) and Frequency modulation ratio ( M_f ) in PWM based inverters?</td>
<td>4</td>
</tr>
<tr>
<td>2.(a)</td>
<td>What are advantages of current-source inverters (CSI)? Explain the working of a three-phase CSI?</td>
<td>8</td>
</tr>
<tr>
<td>2.(b)</td>
<td>With the help of block diagram and waveform explain, the working of hysteresis or tolerance-band type inverters?</td>
<td>4</td>
</tr>
<tr>
<td>3.(a)</td>
<td>Describe with the help of waveforms and mathematical analysis, any multi-level voltage source inverter.</td>
<td>8</td>
</tr>
<tr>
<td>3(b)</td>
<td>What are advantages of multi-level inverters?</td>
<td>4</td>
</tr>
<tr>
<td>4.(a)</td>
<td>With the help of block diagram and waveforms, describe the applications of multi-level inverters in power systems.</td>
<td>8</td>
</tr>
<tr>
<td>4.(b)</td>
<td>With the help of block diagram and waveform explain, how conventional converters (inverters) work as a multi-level inverter.</td>
<td>4</td>
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<td>5.(a)</td>
<td>What are merits and demerits of matrix converters? Explain the working principle of matrix converters?</td>
<td>8</td>
</tr>
<tr>
<td>5.(b)</td>
<td>Show different types of switches (connections/combinations) used in matrix converters.</td>
<td>4</td>
</tr>
<tr>
<td>6.(a)</td>
<td>Select a suitable value of R for the resonant converter circuit shown in figure-1, which has $L = 100 \text{ mH}, C = 100 \mu\text{F}$ and $V_{dc} = 100\text{V}$. Draw current and voltage waveforms of R and find the magnitude of output voltage (across R) at maximum switching frequency.</td>
<td>8</td>
</tr>
<tr>
<td>6.(b)</td>
<td>Explain with the help of wave forms, how is three-phase ac voltage generated by a resonant dc link converter.</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>Write short notes on any TWO of the following topics:</td>
<td>6+6</td>
</tr>
<tr>
<td></td>
<td>(a) Sinusoidal PWM inverters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Space vector modulation of inverters</td>
<td></td>
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<tr>
<td></td>
<td>(c) Current source based LC resonant converters</td>
<td></td>
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<td></td>
<td>(d) Synchronous rectifiers</td>
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![Figure 1](image-url)
QUESTION 1

Develop the reactive capability curve of synchronous generator by taking the effect of armature current limit, field current limit and end-region heating limit.

QUESTION 2

The thermal generating station consisting of four 555 MVA, 24 kV, 60 Hz units supplying power to an infinite bus through two transmission circuit as shown in the figure 1. The network reactances shown in the figure are in per unit on 2220 MVA, 24 kV base (referred to LT side of the step-up transformer). Resistances are assumed to be negligible. The initial-operating conditions and generators parameters are expressed on the same base are given below:

Initial-Operating Conditions:
- \( P = 0.9; Q = 0.436 \) (over excited);
- \( E_t = 1.0\angle30^0; E_B = 0.90081\angle0^0 \)

Generators Parameters:
- \( x'_d = 0.3; H = 3.5 \text{ MW} - s/\text{MVA}; K_d = 0 \)

Circuit 2 experiences a solid three-phase fault at point F, and the fault is cleared by isolating the faulted circuit. Use Transient Energy Function method to find the following:

i. Write the dynamic equations for the post-disturbance system
ii. Write the expression for the system energy function
iii. Calculate the post-disturbance system SEP, UEP and the critical energy
iv. Calculate the energy at fault clearing with \( t_{c1} = 0.07 \text{ s} \) \( (\delta_{c1} = 48.58^0) \), \( t_{c2} = 0.086 \text{ s} \) \( (\delta_{c2} = 52.04^0) \), \( t_{c3} = 0.087 \text{ s} \) \( (\delta_{c3} = 52.30^0) \).

Determine the system stability for each of the three fault durations.

3. Define voltage stability and voltage collapse. Describe the mechanism of voltage instability by \( V - Q \) sensitivity analysis and \( Q - V \) modal analysis.

4. What is Sub-Synchronous Resonance (SSR)? Describe the characteristics of series capacitor compensated transmission system and the mechanism of negatively damped sub-synchronous oscillations.
5. A 100 MVA, 50 Hz generator is connected to an infinite bus through a double circuit line. The generator has inertia constant of 4.0 MJ/MVA at rated speed and the transient reactance is 0.25 pu. Each transmission circuit has a reactance of 0.40 pu on 100MVA base and negligible resistance. The power received at the infinite bus is 50 MW at 0.90 lagging power factor and the infinite bus voltage is $1.0 \angle 0^0$. A three phase short circuit occurs at the terminals of the generator. Calculate the critical clearing angle. Drive the formula used. Also calculate critical clearing time.

6(a). Write dynamical equations, in state space form, of synchronous machine and excitation system separately as used in small signal stability of the power system. Combine the above equations to get overall dynamical equation of a generating unit.

6(b). What is power system stabilizer? Give the block diagram of the practical PSS and discuss the function of various blocks.

7. Write short notes on any TWO of the following:
   i. Q – V curves for voltage stability assessment.
   ii. Voltage collapse proximity indicator.
   iii. Voltage stability index.
1. (a) What are the objectives of FACTS? Discuss, in brief, the various types of FACTS Controllers. 08

(b) Discuss the merits and demerits of VSC based FACTS controllers over variable impedance type controllers 04

2. (a) Discuss the effect of series and shunt compensation schemes on power transfer capability 08

(b) What are the advantages of series compensation? What are the problems associated with its use? 04

3. (a) Explain the basic operating principle and the control capability of unified power flow controller (UPFC). 08

(b) Write a note on TCVR. 04

4. Explain the working, characteristics and operating modes of variable reactance model of thyristor controlled series capacitor (TCSC). Discuss its applications. 12

5. (a) Explain the operation of SSSC and discuss its effect on power flow control. 08

(b) Discuss in brief the role of IPFC in compensation of transmission line. 04

6. (a) Explain the principle of operation and VI characteristic of static synchronous compensator (STATCOM) with a neat sketch. 06

(b) Enumerate the custom power devices that can be used in distribution systems. Discuss, briefly, the role of DVR in distribution system. 06

7. (a) Explain how load compensation is carried out using DSTATCOM. 08

(b) What are voltage sags and voltage swells? Discuss the control objectives of UPQC. 04
2014-15
M.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)
IDENTIFICATION & ESTIMATION
EE-642
Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.                                  Question                                      M.M.
1  Write technical notes on the following:
   i) Parametric and Non parametric Identification
   ii) Black Box and Grey Box Identification
   iii) Baye’s Estimator and its limitations
   iv) Recursive Identification
2(a) Derive the expressions for a linear least square estimation. [07]
2(b) Explain the operation of a Discrete Kalman Filter as Predictor-Corrector algorithm. [05]
3(a) What is the role of white noise in modelling of systems? Also discuss its properties. [05]
3(b) Derive the expressions for a Maximum Likelihood Estimator and test it for various estimator performance characteristics. [07]
4(a) Explain the significance of correlation analysis for identification using noise corrupted measurements. [04]
4(b) Explain the algorithm of Extended Kalman Filter and discuss the problem of Divergence. [08]
5  Derive an expression for the Gain of a Discrete Kalman Filter. [12]
6  Define and explain:
   i. Estimator Bias
   ii. Estimator Covariance
   iii. Asymptotic Unbiased Estimator
   iv. Consistent Estimator
   v. Efficient Estimator
   vi. Asymptotic Efficient Estimator
7  Derive the generalized model structure for Linear Time Invariant systems and obtain different models from it. [12]
2014-15
M.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)
BIO-INSTRUMENTATION
EE-655

Maximum Marks: 60 Credits: 04 Duration: Three Hours

ANSWER ANY FIVE QUESTIONS.
Assume suitable data if missing.
Symbols used have their usual meanings.

Q.No.  Question                         M.M.
1(a)  Discuss in brief the mechanism of depolarization and polarization of a cell. [06]
1(b)  Explain the sequence of events during the transmission of signal across synaptic gap [06]
2(a)  Explain the operation of Magnetic Blood Flow Meters. Why does the electromagnets of blood flow meters that are driven by ac currents are preferred over their dc counterparts. [07]
2(b)  Discuss the various ECG measurement lead configurations and show their measured potential vectors on the Einthoven’s triangle. [05]
3(a)  With the help of relevant waveforms, discuss various control modes and phase variables used in the operation of a ventilator. [08]
3(b)  How electrodes are placed for recording the muscle activity of small muscles? Unlike ECG or EEG equipment, EMG equipment have an amplifier and a loudspeaker also. Why? [04]
4(a)  Discuss various Bio-potential Electrodes and draw the equivalent circuit for the measurement of Bio-potentials. [06]
4(b)  With the help of relevant circuit diagram, explain the working of a DC defibrillator. [06]
5(a)  Explain the various scans in ultrasonic imaging. Also discuss the various modes of ultrasonic transmission. [08]
5(b)  Explain the significance of lung compliance and airway resistance in the operation of ventilators. When does a high frequency ventilator employed? [04]
6(a)  With the help of relevant diagrams, discuss basic components and working principle of Magnetic Resonance Imaging (MRI). [08]
6(b)  Draw a waveform showing various lung volumes and capacities. Which of these can be measured using a spirometer and why? [04]
7(a)  Discuss in brief the various transducers used for the measurement of skin temperature. [06]
7(b)  Blood pressure is to be monitored for a patient using a strain gauge type transducer from a remote location. Explain the various stages needed for such blood pressure telemetry system. [06]
2014-15
M.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
MICRO ELECTRO-MECHANICAL SYSTEMS (MEMS)
EE-656

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer Any FIVE questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.   Question                                                                                     M.M.
1(a)   What are the various technological aspects of sensors? Explain.                              [08]
1(b)   Distinguish among Crystalline, Polycrystalline and Amorphous structures of materials.         [04]

2   Explain the following phenomena used in MEMS devices:                                            [12
    (a) Piezo-resitivity.                                                                            =3x4]
    (b) Piezo-electricity.                                                                           
    (c) Thermo resistivity.                                                                         
    (d) Pyroelectricity.                                                                            

3(a)   Differentiate between Isotropic and Anisotropic etching.                                      [04]
3(b)   Describe the following thin film deposition procedure:                                       [08
    (a) Spin casting.                                                                               =3+5]
    (b) Evaporation.                                                                               

4   What is LIGA process? Describe the steps involved in LIGA process. Mention its advantages and limitations. [12]

5(a)   What are the Principles of Micro Stereo Lithography (MSL)?                                    [06]
5(b)   Describe Integrated Hardened (IH) MSL. Mention its characteristics and limitation.           [06]

6   Explain the principle of operation of thin film anemometer flow sensor. Describe its design and fabrication procedure. [12]

7(a)   Mention different types of MEMS Inertial sensor and its Application.                          [04]
7(b)   Explain the principle of operation of MEMS accelerometer and describe its mechanical model.   [08]
2014-15
M.TECH. IIrd SEMESTER EXAMINATION
M.Tech (Electrical)
Power System & Drives/High Voltage & Insulation Engineering
High Voltage Testing Techniques
EE-663
Credits: 04
Duration: Three Hours

Maximum Marks: 60

Answer any FIVE questions.

1(a) With the help of a circuit, explain a multi stage impulse generator. [06]
1(b) Briefly discuss the high voltage impulse testing of surge arresters. [06]

2(a) Explain the methods for producing switching impulses in test laboratories. [06]
2(b) Using a circuit explain how rectangular current pulses are generated. Also give its applications. [06]

3(a) How are faults in transformer insulation detected and located during impulse testing? [06]
3(b) Explain the factors that affect the sparkover voltage of spark gaps. [06]

4(a) Using suitable mathematical expression show that an impulse wave is composed of two exponential waves. [06]
4(b) Discuss the various components of impulse voltage test system. [06]

5(a) Discuss the impulse testing of transformer. Also state the sequence for impulse testing. [06]
5(b) Why is controlled tripping of impulse generator necessary? Explain operation of a three electrode gap. [06]

6(a) What are delay cables? With the help of circuit diagram, explain various arrangements of potential dividers. [06]
6(b) Discuss one method for measurement of high impulse currents. [06]

7(a) With the help of a block diagram, explain how impulse measurement is done using a CRO. [06]
7(b) What is a rod gap? Explain its utility for impulse testing. Also state the factors on which sparkover voltage depends. [06]
1. Explain, why it is necessary to consider distributed nature of parameters of a high voltage transmission line. Giving simplifying assumptions, derive the expressions for travelling voltage and current waves on a line. What would happen, if two voltage waves of equal magnitude travels with the same velocity but in opposite direction?

2(a) Derive expressions for reflection and refraction coefficients. [06]

2(b) Explain, what would happen if a square voltage wave travelling on a line is suddenly terminated into (i) a capacitor and (ii) an inductor. Draw necessary incident, reflected and refracted waves of currents and voltages. [06]

3(a) Derive an expression for initial voltage distribution along the windings of a high voltage large power transformer when it is attacked by a lightning stroke. Show that the maximum potential gradient would be $\left( \frac{\alpha V}{1} \right)$, and that it would occur at the first few turns of the winding. Various terms used have their usual meanings. [08]

3(b) What are indirect lightning strokes? How do they affect a transmission line. [04]

4(a) Giving a neat diagram explain how a thunder cloud cell as referred to natural lightning phenomenon is formed. [06]
4(b) Giving a neat sketch, mention various times and discuss temporal development of a lightning flash to open grounds.

5(a) With the help of a diagram explain working of surge diverters? How do they protect transmission lines?

5(b) Define T.F.R. What is its role in protecting the lines? Discuss why and how its value could be reduced?

6(a) What are Isokeraunic Charts? Discuss the significance of these charts. How are they prepared?

6(b) The three strings of line insulators in each circuit of a double circuit, 3-phase, 220 kV transmission line lie in a vertical plane with conductor to conductor gap spacing of 5.5 meters. The horizontal spacing between two circuits is 10 meter. The highest conductor belonging to a circuit above the ground is at 30.5 meter. Consider the following data for the line and determine its ‘Flashover Rate’.

The sag in each power conductor: 9.0 meter.
No. of discs in each string: 15
Flashover value of each disc: 80 kV
Surge impedance of line: 480 Ohms
Probability of lightning stroke for lightning current of 5.0 kA: 97 %

7. Write notes on any THREE of the following [4+4+4]

(a) Expulsion Gaps
(b) Prediction of ‘Back Flashover Rates’
(c) Attenuation of travelling waves
(d) Protection of lines using OHG wires
(e) Development of lightning flash to high rise buildings.
2014-15
M.TECH. (WINTER SEMESTER) EXAMINATION
Electrical Engineering
Insulation Technology for Superconductors
EE-667
Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

1 (a) Discuss the technologies and their advantages that were enabled by superconductivity. Also discuss the benefits of superconductivity in power applications.

(b) Discuss the environment, safety and health impact of HTS power equipment.

2 Discuss the desired properties of electrical insulating materials at cryogenic temperature. Justify with example that the mechanical and thermal properties of insulating materials are more demanding at cryogenic temperatures.

3 Discuss the factors which influence dielectric strength of electrical insulating materials in ambient medium and hence deduce the breakdown strength equation as suggested by Swanson. Also explain how this equation gets modified if thickness isn't incorporated and the medium is liquid nitrogen (LN₂).

4 Explain with a neat sketch, why ac breakdown voltage in LN₂ as a function of electrode diameter for different gap lengths decreases after a certain critical diameter size. Also draw neat sketch of average breakdown voltage versus (SLV) 90 for coaxial electrode configuration and explain the volume effect mechanism in LN₂.

5 Why it is essential to study dielectric breakdown characteristics of cryogenic nitrogen gas above liquid nitrogen? Also discuss the breakdown of cryogenic gas under uniform and non-uniform fields and show how they are correlated.

6 Discuss the loss index and breakdown strength of electrical insulating materials at cryogenic temperature. Why refrigeration load needs special attention at such temperatures?

7 Discuss the PDI characteristics in artificial air filled voids at room and cryogenic temperatures. What are the factors which reduce the discharge repetition rate at low temperatures?
Q.No. | Question | M.M.
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1 | Differentiate and distinguish between various types of discharges that occur in high voltage insulation systems. With suitable diagrams, give the classification of various types of partial discharges occurring in electrical power equipment. | [12]
2 | Explain the recurrence of discharges when an insulating medium is subjected to an AC voltage. Explain why the repetition rate under DC voltage is several orders lower than at AC voltage? | [12]
3(a) | With neat sketches, explain the phenomena of inception of positive and negative Corona discharges and their recurrence. | [06]
3(b) | With suitable sketches, explain the phenomena of occurrence of partial discharges in cavities below the inception voltage. | [06]
4 | Explain the ABC-model of discharges occurring in a cavity within a dielectric. What are the limitations of this model? Using the ABC-model explain the phenomena of interaction of two discharges in a cavity by transverse leakage. | [12]
5 | Justify the measurement of apparent charge as a measure of the magnitude of partial discharges. Derive an expression for discharge magnitude and discharge energy from a single discharge due to breakdown of a void in a solid insulation. | [12]
6 | Discuss various electrical and non-electrical methods for locating partial discharges in high voltage equipment. Also draw the basic diagram of electrical discharge detection circuit and explain it. | [12]
7 | Explain in detail the phenomena of occurrence of partial discharges and its detection in any one of the following:
   (a) Capacitors
   (b) Cables
   (c) Transformers. | [12]
Question

1(a) Explain the classical optimization techniques for determining the optimum value of function. What are the assumption made and which type of problems can be handled by these techniques?

1(b) Briefly explain each of the major Advance Optimization Techniques being used currently.

2(a) State multivariable optimization problem without constraints. Determine the maximum and minimum values of the function \( f(x) = 12x^5 - 45x^4 + 40x^3 + 5 \).

2(b) Find the dimensions of a cylindrical tin with top and bottom made up of sheet metal to maximize its volume so that total surface area, \( A = 24 \pi \).

3. Find the maximum of the function \( f(x) = x(1.5 - x) \) by starting from 0 with initial step size of 0.05 by unrestricted search method. Explain the steps involved in Exhaustive search method.

4. Maximize the function \( f(x) = -(x - 4.1)^2 \) having \( a = 3, b = 5\) & \( \epsilon = 0.0001 \) using Golden Section method. Draw the flow chart for the steps involved in Fibonacci method.

5. With reference to Dynamic programming write short notes on the following:
   (i) Knapsack Problem  (ii) Shortest Path Problem  (iii) Warshall’s Algorithm

6. Write the steps involved in solving Conjugate Gradient Method and Variable Metric Methods. Minimize the function \( f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2 \) from the initial point \( (0, 0) \) using Conjugate Gradient Method.

7. Draw the flow chart for finding the optimal solution by simplex algorithm. If each scientific calculator sold results in a loss of Rupees 2/-, but each graphing calculator produces a profit of Rupees 5/-, how many of each type should be made daily to maximize net profit?