## Code No. 2587

**2017-2018**  
**II Semester M. Tech. Examination**  
**(Electrical Engineering)**  
**Adv. Electric Drives - II**  
**(EE-612N)**  
**Maximum Marks: 60**  
**Credits: 04**  
**Duration: Two Hours**

**Note:**  
(i) Answer any Four questions.  
(ii) Symbols have their usual meaning.  
(iii) Assume suitable value for missing data.

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Derive the condition for maximum torque developed in an induction motor when it is operated from a variable frequency supply. Using above result find the expression for maximum torque developed. Discuss the operation at sub-synchronous speed.</td>
<td>06</td>
</tr>
<tr>
<td>1(b)</td>
<td>What are the disadvantages of induction motor operation with unbalanced supply voltages?</td>
<td>02</td>
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</tbody>
</table>
| 1(c)     | A 37.3 kW, 460 V, 60 Hz, 6 pole, 1180 rpm, Y-connected squirrel cage IM has following parameters per phase referred to stator:  
\[
R_s = 0.19 \Omega, \ X_L = 0.75 \Omega, \ X_m = 20 \Omega, \ R_f' = 0.07 \Omega, \ X_f' = 0.38 \Omega
\]  
The motor is used for regenerative braking, Calculate:  
(a) the range of active torque it can hold and corresponding speed range  
(b) maximum power it can generate and maximum mechanical power it can produce as motor.  
(c) Speed at developed braking torque of 300 Nm. | 07    |
| 2(a)     | What do you understand by VSI and CSI controlled induction motor drives? Compare their relative merits and demerits. | 05    |
| 2(b)     | A 460 V, 60 Hz, 4 pole, 1760 rpm, Y-connected wound-rotor induction motor has following parameters per phase referred to stator:  
\[
R_s = 0.14 \Omega, \ X_L = 0.4 \Omega, \ R_f' = 0.1 \Omega, \ X_f' = 0.7 \Omega, \ X_m = 8 \Omega
\]  
The motor is controlled by a static Scherbius scheme. The drive is designed for speed range of 30 percent below the synchronous speed. The resistance of the filter inductor is negligible. The maximum value of firing angle is 165°.  
(i) Calculate the torque and power factor for \(\alpha = 105^0\) and 960 rpm.  
(ii) Now the transformer is removed and the inverter is connected directly to the ac mains. The firing angle is adjusted to get the same torque and speed as in (i). Calculate the power factor and compare it with that obtained in (i). Neglect friction, windage and core losses. | 10    |
| 3(a)     | A three-phase wound rotor induction motor with external resistors in the rotor is | 04    |

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**Contd... 2**
| (b) | A 37.3 kW, 460 V, 60 Hz, 6 pole, 1180 rpm, Y-connected squirrel cage IM has following parameters per phase referred to stator: 
\[ R_s = 0.19 \Omega, \ X_{ls} = 0.75 \Omega, \ X_m = 20 \Omega, \ R_r' = 0.07 \Omega, \ X_{lr}' = 0.38 \Omega \]  
Plugging is used for the speed reversal of this IM from full-load speed. What changes must be made in its connection? Calculate the initial braking torque and current as a ratio of their full-load values. (Use exact equivalent circuit). |
| (08) CO 1,3 |

| 4(a) | Explain the operation of an induction motor when its speed is controlled by injecting a voltage at the terminals of its rotor. Derive the expression for the developed torque in terms of injected voltage. Also discuss the condition and the operations of the motor in sub-synchronous and super-synchronous speed ranges for its motoring and braking modes of operations. |
| (07) CO 1,2,4 |

| (b) | A 460 V, 60 Hz, 4 pole, 1720 rpm, Y-connected IM has following parameters per phase referred to stator: 
\[ R_s = 0.5 \Omega, \ R_r' = 0.2 \Omega, \ X_s = X_r' = 1 \Omega, \ X_m = 30 \Omega \]  
The motor is braked with variable frequency control by regenerative braking at constant rated flux. Calculate:  
(a) The frequency at 1200 rpm and rated braking torque  
(b) The motor speed at half the rated braking torque and 30 Hz. 
Use exact equivalent circuit. |
| (08) CO 1,2 |

| 5(a) | What is a Space Vector PWM (or SVM) technique? How its implementation is done for the speed control of induction motor? Mention its advantages. |
| (08) CO 3,4 |

| (b) | Draw a neat labelled diagram of a static Scherbius drive for induction motor. Derive its equivalent circuit. Establish the mathematical expression for the developed torque and draw the speed-torque characteristics. What are the salient features of this drive? |
| (07) CO 1,2 |

| 6(a) | Briefly describe the method of transforming abc-reference frame to stationary qdq-reference frame. Also give the method to transform stationary qdq-reference frame to synchronously rotating reference frame. |
| (05) CO 1,2 |

| (b) | What are salient features of vector control of induction motor? What are different ways to implement it? Explain the principle of vector control of induction motor. Give any one method for the implementation of vector control algorithm in an induction motor based drive. |
| (10) CO 2,3 |
2017-18
II\textsuperscript{nd} SEMESTER M.TECH. EXAMINATION
(Power system & Drives And High Voltage & Insulation Engg.)
POWER SYSTEM STABILITY
EE-633

Maximum Marks: 60
Credits: 04
Duration: Two Hours

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

Q.No. Question M.M.
1(a) Discuss the procedure for solving the swing equation using Runge Kutta 4\textsuperscript{th} order method. [7.5] [CO1]
1(b) A two-pole, 60-Hz synchronous generator has a rating of 250 MVA, 0.8 power factor lagging. The kinetic energy of the machine at synchronous speed is 1080 MJ. The machine is running steadily at synchronous speed and delivering 60 MW to a load at a power angle of 8 electrical degrees. The load is suddenly removed. Determine the acceleration of the rotor. If the acceleration computed for the generator is constant for a period of 12 cycles, determine the value of the power angle and the rpm at the end of this time. [7.5]
2(a) What is Small Signal Stability and what are the various modes of oscillations? Explain. [7.5] [CO1]
2(b) What is Power System Stabilizer (PSS)? What are possible input signals to it? Draw the functional block diagram of PSS and discuss the function of each block. [7.5] [CO4]
3(a) Write the Computer Algorithm to determine transient stability of Multi machine system. [7.5] [CO2]
3(b) Draw the Flow Chart to compute transient stability using Modified Euler Method. [7.5] [CO5]
4(a) State Liapunov stability theorem. Obtain the expressions for Critical Transient Energy Function $V_c\alpha$ and the transient energy at critical clearing angle $V_c\theta$ for single machine infinite bus system using Liapunov Method. [7] [CO2]
4(b) The generating station consisting of four 555 MVA, 24 kV, 60 Hz units supplying power to infinite bus through two transmission circuit as shown in Fig. 1. The network reactances shown in the Fig. are in per unit on 2220 MVA, 24 kV base (referred to LT side of the step-up transformer). The resistances are assumed to be negligible. The initial contd...
operating conditions and generator parameters are expressed on the same base are given below:

Initial Operating Conditions:

\[ P = 0.9; \quad Q = 0.436 \text{ (over excited)} \]; \quad E_t = \angle 1.0 30^\circ; \quad E_B = 0.90081\angle 0^\circ

Generator Parameters:

\[ x_d' = 0.3; \quad H = 3.5 \text{ MW-s/MVA}, \quad K_D = 0 \]

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

(a) calculate the post disturbance system SEP, UEP and the critical energy \( V_{cr} \).
(b) calculate the energy at fault clearing time with \( t_{c1} = 0.07 \text{ s} \) (\( \delta_{c1} = 48.58^\circ \)), and \( t_{c2} = 0.087 \text{ s} \) (\( \delta_{c2} = 52.30^\circ \)). Determine system stability for each fault conditions.

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5(a) Define Sub Synchronous Resonance. Explain the difference between Sub Synchronous Resonance and Sub Synchronous Oscillation. Discuss the basic theory behind Sub Synchronous Resonance in a series capacitor compensated line.

5(b) Deduce the relationship between normalised power and normalised voltage at receiving end to get family of P-V Curve at various power factors.

6(a) Explain how to determine the voltage stability by Q-V modal analysis.

6(b) Discuss the \( dQ/dV \) criterion for assessing voltage stability.

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Fig.1

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Maximum Marks-60 Credit-04 Time- 2 Hours

NOTE: (i) Answer any four questions.
(ii) Notations used have their usual meaning.
(iii) Assume suitable data, wherever necessary.

1. (a) Discuss the objectives of FACTS Controllers in the power system network. 10
Explain, in detail, about the classification of different types of FACTS Controllers.

(b) Discuss the role of SVC in the enhancement of power system damping. Draw its 05
V-I characteristic with a neat sketch.

2. (a) What are active and passive compensators? Explain, in detail, about the series 10 CO1
and shunt compensation in transmission lines.

(b) What is the difference between TSSC and TCSC? 05 CO2

3. (a) Explain the basic operating principle and the control capability of unified power 10 CO3
flow controller (UPFC).

(b) Discuss, in brief, the role of IPFC in compensation of transmission line. 05 CO3

4. Explain the different modes of operation in TCSC. Derive the expression for 15 CO3
impedance offered by the TCSC (X_{TCSC}). Discuss its applications.

5. (a) Why do you prefer voltage source converters in FACTS devices? Discuss the 10 CO3
operating principle of an SSSC. How is it different from a TCSC?

(b) What role does UPQC play in improving the Power Quality of the distribution 05 CO4
system.

6. (a) Discuss the role of DVR in distribution system. Explain briefly how load 10 CO4
compensation is carried out using DSTATCOM.

(b) Enumerate the custom power devices that can be used in distribution systems. 05 CO4
Discuss, briefly, the role of each device.
2017-18
M.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)
IDENTIFICATION & ESTIMATION
EE-642
Credits: 04
Duration: Two Hours

Maximum Marks: 60

Answer All 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) Cramer Rao Lower Bound
   iii) Impulse Response Identification
   iv) Recursive Identification (CO-1,3) | [12]
2 | Derive the generalized model structure for Linear Time Invariant systems and obtain different models from it. (CO-1,3) | [12]
3(a) | Derive the expressions for a Linear Least Squares Estimation. (CO-2) | [07]
3(b) | Explain the operation of a Discrete Kalman Filter as Predictor-Corrector algorithm. (CO-4) | [05]

OR

3'(a) | Discuss properties and role of Correlation Functions in modelling of systems. (CO-1) | [05]
3'(b) | Derive the expressions for a Recursive Least Squares Estimator and mention the condition when the results of recursive and non-recursive estimations are same. (CO-2) | [07]
4(a) | Explain the significance of spectral density for identification using noise corrupted measurements. (CO-1,3) | [04]
4(b) | Explain the algorithm of Extended Kalman Filter and discuss the problem of Divergence. (CO-4) | [08]

OR

4' | Derive an expression for the Gain of a Discrete Kalman Filter. (CO-4) | [12]
5 | Define and explain:
   i. Estimator Bias
   ii. Estimator Covariance
   iii. Asymptotic Unbiased Estimator
   iv. Consistent Estimator
   v. Efficient Estimator
   vi. Asymptotic Efficient Estimator (CO-1,3) | [12]
Q. No.                  Question                                                                                           M.M.

1 a). Draw a block diagram showing various disturbances which can act on the system. [05]

1 b). For a series RLC system $\Delta_{ar}$, $\Delta_{al}$ and $\Delta_{ac}$ are uncertainties in resistance, inductance and capacitance respectively. If current is taken as output and supply voltage as input:

   i. Draw the perturbed state-space block diagram of the system.
   ii. Write down its corresponding state-space equations.

OR

1 b'). A system is represented in P-\(\Delta\) form as shown in figure 1.

\[
\begin{align*}
&\text{\(\Delta\)} \\
&\text{\(w(t)\)} \\
&\text{\(u(t)\)} \\
&\text{\(P(s)\)} \\
&\text{\(z(t)\)} \\
&\text{\(y(t)\)} \\
&\text{\(K(s)\)} \\
&\text{\(R(s)\)} \\
&\text{\(z(t)\)} \\
&\text{\(y(t)\)}
\end{align*}
\]

   Figure 1

   Figure 2

   i. Derive the transfer functions in P(\(s\)) matrix in terms of state space matrices $A$, $B_1$, $B_2$, $C_1$, $C_2$, $D_{11}$, $D_{12}$, $D_{21}$ and $D_{22}$.
   ii. Derive the transfer functions in new R(\(s\)) matrix which is formed by combining P(\(s\)) and \(\Delta\) (figure 2).

2 a). For a system having transfer function matrix $G(s)$ write down the steps to find out the H-infinity norm $\|G(s)\|_{\infty}$ by using the theory of Singular Value Decomposition. [7.5]

\(\text{contd...}\)
2 b). Explain the Singular Value Decomposition of a complex matrix and discuss the various properties of the matrices obtained after decomposition.

OR

2 b'). Using the theory of singular value decomposition, show that for a given transfer function matrix of a MIMO system, the gain of the system does not only depend on the frequency but also on the input direction vector.

3 a). A ball \( B(0,\varepsilon) \) is given such that in that ball the states \( x \leq \varepsilon \). Boundary of the ball \( \partial B_\varepsilon \) is defined for all \( x \) such that \( \|x\| = \varepsilon \). Let \( \alpha \) be the minimum value of Lyapunov function \( V(x) \) at the boundary \( \partial B_\varepsilon \). If there is a set \( \Omega_\beta \) such that for all \( x \in \Omega_\beta, V(x) \in (0, \beta) \) where \( \beta \leq \alpha \).

Using the properties of Lyapunov function prove that if such \( \Omega_\beta \) exists then,

i. \( \Omega_\beta \) lies inside ball \( B(0,\varepsilon) \)

ii. \( \Omega_\beta \) is a positively invariant set

3 b). A system is described by the state space equation:

\[
\dot{y} = -ay + bu
\]

State space equation of the reference model is:

\[
\dot{y}_m = -a_my_m + b_mu_c
\]

The controller output is given as:

\[
u = \theta_1u_c - \theta_2y
\]

Design a Model Reference Adaptive Control System using MIT rule.

OR

3' a). With the help of a block diagram explain the operation of Model Reference Adaptive Control System. Discuss the MIT and Lyapunov rule for the adaptation of controller parameters.

3' b). A system is described by the state space equation: \( \dot{x} = Ax + Bu \)

State space equation of the reference model is: \( \dot{x}_m = A_mx_m + B_mu_c \)

The controller output is given as: \( u = -Lx + Mu_c \)

i. Form an appropriate Lyapunov function.


4 b). Write down the all steps to solve for H-infinity control problem for a system in the presence of disturbances. Also state all the necessary and desired assumptions to solve the H-infinity control problem.
# 2017-18
M.TECH. WINTER (II SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)
DIGITAL INSTRUMENTATION
EE-653

Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

**Answer any FOUR 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>
</thead>
<tbody>
<tr>
<td>1 (a)</td>
<td>Describe the principle of operation of successive approximation type DVM. (CO-1)</td>
<td>05</td>
</tr>
<tr>
<td>1 (b)</td>
<td>With the help of neat diagram explain how current to voltage converter circuit is implemented to measure unknown currents in digital multimeter. (CO-1)</td>
<td>10</td>
</tr>
<tr>
<td>2 (a)</td>
<td>Mention the features of IC ADC0808. (CO-2)</td>
<td>05</td>
</tr>
<tr>
<td>2 (b)</td>
<td>Discuss the steps involved in a typical data acquisition system. (CO-2)</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>What is a Logic Analyzer? Discuss the difference between logic state analyzer and logic timing analyzer. (CO-3)</td>
<td>15</td>
</tr>
<tr>
<td>4 (a)</td>
<td>Explain the working of capacitive relative humidity sensor. (CO-4)</td>
<td>05</td>
</tr>
<tr>
<td>4 (b)</td>
<td>What are digital encoders? Explain the working of resistive and magnetic encoders. (CO-4)</td>
<td>10</td>
</tr>
<tr>
<td>5 (a)</td>
<td>Describe the working of a digital LCR meter in brief. (CO-1)</td>
<td>05</td>
</tr>
<tr>
<td>5 (b)</td>
<td>Discuss the difference between Fourier transform analyzer and Swept tuned analyzer. (CO-3)</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>With the help of pulse diagram and related diagrams, explain the working of Asynchronous and Synchronous decade counter. Also, discuss how a Mod-1000 counter can be implemented? (CO-1, CO-4)</td>
<td>15</td>
</tr>
</tbody>
</table>
Maximum Marks: 60
Credits: 04
Duration: 2 Hours.

Attempt all questions

Q1 Describe the electrical, magnetic, optical, thermal, and mechanical properties of nanostructured materials. (CO1) 15

Q2a Discuss the Classification of Nanomaterials. (CO1) 7

Q2b Distinguish between optical microscopies and electron microscopies schematically, explain transmission electron microscopy. (CO2) 8

Q2’a Explain X-Ray Diffraction techniques for structural characterization of nanomaterials. (CO2) 7

Q2’b What are the energy band structures in metals, semiconductors and insulators? Explain the energy band gap calculations using Tauc plot. (CO2) 8

Q3a What is supercapacitor? Explain with neat sketch, the application of super capacitor for power quality improvement. (CO3) 7

Q3b With neat sketch, explain nano sensors. (CO3) 8

OR

Q3’b What are the advantages and limitations of nanomaterials? Describe their possible applications. (CO1) 8

Q4a With neat sketch, explain the design of dye sensitized solar cells. (CO4) 7

Q4b What is perovskite? Explain the principle of perovskite solar cells. (CO4) 8

OR

Q4’b Write technical notes on nanomaterials for green energy. (CO4) 8
1(a) 'Impulse wave is composed of two exponential waves'. Justify the statement. [7.5]
1(b) What is a Tesla coil? How is damped high frequency oscillations obtained from a Tesla coil? [7.5]
2(a) What is a Trigatron gap? Explain its function and operation. [7.5]
2(b) What are the different shunts used for impulse measurements? Also discuss ‘Rogowski Coil’ as used for measurement of high impulse currents. [7.5]
3(a) With the help of a layout of an impulse laboratory indicating control and signal cables, explain the various components of the arrangement. [7.5]
3(b) Explain with suitable circuit diagram Marx circuit arrangement for generation of impulse waves. [7.5]
4(a) Explain the necessity of earthing shielding arrangements in impulse measurements and in high voltage laboratories. Give a sketch of the multiple shielding arrangements used for impulse voltage and current measurements. [7.5]
4(b) What are the significances of power factor tests and partial discharge tests on bushings? How are they conducted in the laboratory? [7.5]
5(a) Explain the different methods of producing switching impulses in test laboratories. [7.5]
5(b) Discuss any two high current impulse tests on surge arrestors. [7.5]
6(a) Explain the partial discharge tests on high voltage cables. How is a fault in the insulation located in this test? [7.5]
6(b) Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure? [7.5]
2017-18
M.Tech. (Winter Semester) Examination
Electrical Engineering (High Voltage & Insulation Engg.)
Electrical Insulation for Rotating Machines
EE-666N

Maximum Marks: 60  Credits: 04  Duration: Two Hour

Answer any four of the following six questions. Assume suitable data if missing.
Notations used have their usual meaning.

Questions

1. (a) With the help of a neat diagram explain strand, turn and groundwall insulation for form-wound stator winding insulation system.
   [8]

   (b) Describe the process for reducing the thermal impedance of the ground wall insulation. Also, explain how electric stress is increased.
   [7]

2. (a) Explain the mechanical and electrical reasons for stranding a conductor in a form-wound coil or bar. Also, explain the need for transpositions of the copper strands.
   [8]

   (b) Why the stresses experienced by rotor winding insulation are different from those in the stator winding insulation.
   [7]

3. (a) Discuss the mechanical and electrical transient that occur before the failure of the windings. Also, enumerate different motor components responsible for failure along with its percentage.
   [8]

   (b) Discuss the factors that affect repair decisions. Also, explain the consequences of cutting out stator coils after failure.
   [7]

4. (a) Discuss the advantages and disadvantages of online monitoring of machines. Also, explain several problems associated with visual inspections.
   [8]

   (b) Describe different common offline stator test and compare these with respect to its performance difficulty level and effectiveness.
   [7]

contd... 2
5. (a) Write short notes on the historical developments of Mica and Epoxy resins. [8]
   (b) Describe different common offline rotor test and compare these with respect to its performance difficulty and effectiveness. [7]

6. (a) Explain the purpose of the turn insulation. Draw the diagram of the cross section of a coil where the turn insulation and the strand insulation are the same. [8]
   (b) Explain the method for direct-cooled rotor insulation. Also, describe Roebel transpositions insulation system. [7]
Answer any four 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. [07]

(b) Calculate the critical current and the critical current density at 0 K, for a long wire of lead which has a circular cross section of radius 5mm. Also calculate the current density at 4 K. 

Given: Critical field for lead at 0 K = 803x10^4 Tesla and T_c = 7.193 K. [08]

2(a) What is the environment, safety and health impact of HTSC power equipment? [06]

(b) Discuss the pressure dependence of dielectric breakdown in liquid nitrogen and the desired properties of electrical insulating materials at cryogenic temperature. [09]

3 Explain with a neat sketch, why ac breakdown voltage in LN_2 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 LN_2. [15]

4(a) Compare the non-uniform field breakdown characteristics of liquid nitrogen and liquid helium. Why cryogenic liquids are suitable for medium high voltage domain? [06]

(b) Discuss the factors which influence dielectric strength of electrical insulating materials in ambient medium and hence deduce the breakdown strength equation in terms of these factors incorporating thickness of the sample. [09]

5(a) Explain the terms dielectric polarization, interfacial polarization and ionic oscillation. [06]

(b) Discuss in brief the breakdown of cryogenic gas under uniform and non-uniform fields and show how they are correlated using field utilization factor. [09]

6(a) Discuss the impulse characteristics of electrical insulation operating at cryogenic temperature. What are the factors on which impulse breakdown strength is dependent? [07]

(b) Discuss the deterioration and breakdown of solid dielectrics by internal discharges at cryogenic temperature. What are the factors which reduce the discharge repetition rate at low temperatures? [08]
Maximum Marks: 60

Answer any four questions.
Notations used have their usual meaning.

Q.No. | Question | M.M.
--- | --- | ---
1(a) | With neat sketches, explain the phenomena of inception of positive and negative Corona discharges and their recurrence. | [06]
1(b) | With suitable sketches, explain the phenomena of occurrence of partial discharges in cavities below the inception voltage and hence show that the minimum voltage at which discharges can persist can be almost one-half of the inception voltage. | [09]
2 | 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. | [15]
3 | Explain various quantities related to the magnitude of discharges. Derive an expression for discharge magnitude and discharge energy from a single discharge due to breakdown of a void in a solid insulation and hence justify choice of ‘apparent charge’ as a measure for partial discharges. | [15]
4 | Enumerate various non-electrical methods for partial discharge detection in high voltage equipment. Explain the principle of partial discharge detection using acoustic and optical methods in electrical systems. | [15]
5 | With suitable sketches discuss the principle of electrical discharge detection circuit for measurement of partial discharges. Explain the need for providing a coupling capacitor in the circuit. | [15]
6 | 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 | [15]
2017-18
M.TECH. (WINTER SEMESTER) EXAMINATION
POWER SYSTEM & DRIVES/ INSTRUMENTATION & CONTROL
OPTIMIZATION TECHNIQUE
EE678

Maximum Marks: 60 Credits: 04 Duration: Two Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q. No. Questions
1 (a) Briefly explain the following terms with reference to classical optimization:
   i. Linear programming problem
   ii. Stochastic programming problem
   iii. Geometric programming problem
   iv. Quadratic programming problem

1 (b) A fertilizer company purchases nitrates, phosphates, potash, and an inert chalk base at a cost of $1500, $500, $1000 and $100 per ton, respectively, and produces four fertilizers A, B, C and D. The production cost, selling price and composition of the four fertilizers are given below.

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Production cost ($/ton)</th>
<th>Selling price ($/ton)</th>
<th>Percentage composition by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>350</td>
<td>5  10  5  80</td>
</tr>
<tr>
<td>B</td>
<td>150</td>
<td>550</td>
<td>5  15  10  70</td>
</tr>
<tr>
<td>C</td>
<td>200</td>
<td>450</td>
<td>10 20  10  60</td>
</tr>
<tr>
<td>D</td>
<td>250</td>
<td>700</td>
<td>15  5  15  65</td>
</tr>
</tbody>
</table>

During any week, no more than 1000 tons of nitrates, 2000 tons of phosphates and 1500 tons of potash will be available. The company is required to supply a minimum of 5000 tons of fertilizer A and 4000 tons of fertilizer D per week to its customers; but it is otherwise free to produce the fertilizers in any quantities it pleases. Formulate the problem of finding the quantity of each fertilizer to be produced by the company to maximize its profit.
1\(^{(a)}\) Two copper-based alloys (brasses), A and B, are mixed to produce a new alloy, C. The composition of alloys A and B and the requirements of alloy C are given in the following table:

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Copper</th>
<th>Zinc</th>
<th>Lead</th>
<th>Tin</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>60</td>
<td>20</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>≥ 75</td>
<td>≥ 15</td>
<td>≥ 16</td>
<td>≥ 3</td>
</tr>
</tbody>
</table>

If alloy B costs twice as much as alloy A, formulate the problem of determining the amounts of A and B to be mixed to produce alloy C at a minimum cost.

1\(^{(b)}\) A manufacturer of a particular product produces \(x_1\) units in the first week and \(x_2\) units in the second week. The number of units produced in the first and second weeks must be at least 250 and 450, respectively to be able to supply the regular customers. The initial inventory is zero and the manufacturer ceases to produce the product at the end of the second week. The production cost of a unit, in dollars, is given by \(4x_i^2\), where \(x_i\) is the number of units produced in week \(i\) (\(i = 1, 2\)). In addition to the production cost, there is an inventory cost of $10 per unit for each unit produced in the first week that is not sold by the end of the first week. Formulate the problem for minimizing the total cost.

2\(^{(a)}\) Write the necessary and sufficient conditions for the minimum or maximum of an unconstrained multivariable function.

2\(^{(b)}\) Find the extreme points of the function

\[
f(x_1, x_2) = 2x_1^3 + 3x_2^3 + 2x_1^2 + 4x_2^2 + 5
\]

OR

2\(\) Find the dimensions of a box of largest volume that can be inscribed in a sphere of unit radius.

3\(^{(a)}\) Using Lagrange multiplier method, find the maximum of the function

\[
f(X) = 2x_1 + x_2 + 10
\]

Subject to

\[
g(X) = x_1 + 2x_2^2 = 3
\]

3\(^{(b)}\) Solve the following optimization problem using Kuhn-Tucker conditions.

Minimize \(f(x_1, x_2, x_3) = x_1^2 + 2x_2^2 + 3x_3^2\)

Subject to

\[
x_1 - x_2 - 2x_3 \leq 12
\]
\[
x_1 + 2x_2 - 3x_3 \leq 8
\]
4 (a) Solve the following optimization problem using simplex method.

Maximize \( f = x_1 + 2x_2 + x_3 \)

Subject to
\[
\begin{align*}
2x_1 + x_2 - x_3 &\leq 2 \\
-2x_1 + x_2 - 5x_3 &\geq -6 \\
4x_1 + x_2 + x_3 &\leq 6 \\
x_i &\geq 0, \; i = 1, 2, 3
\end{align*}
\]

4 (b) Solve the following two-stage dynamic programming problem

Maximize \( f(x_1, x_2) = 50x_1 + 100x_2 \)

Subject to
\[
\begin{align*}
10x_1 + 5x_2 &\leq 2500 \\
4x_1 + 10x_2 &\leq 2000 \\
x_1 + 1.5x_2 &\leq 450 \\
x_1 &\geq 0, \; x_2 &\geq 0
\end{align*}
\]

5 Solve the following optimization problem using Powell’s method by assuming tolerances as \(10^{-3}\).

Minimize \( f(x_1, x_2) = (x_1 - 1.5x_2)^2 + (x_2 - 2)^2 + 3 \)

Subject to
\[
\begin{align*}
0 &\leq x_1 \leq 5 \\
0 &\leq x_2 \leq 5
\end{align*}
\]

OR

5’ Solve the following optimization problem in the interval \([0, 3]\) by Fibonacci method using \(n = 6\).

Minimize \( f(x) = 0.65 - [0.75/(1 + x^2)] - 0.65 \times \tan^{-1}(1/x) \)