2013-14
B.TECH. (AUTUM SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
COMPUTER METHODS IN POWER SYSTEMS
EE 436

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No. Question

1(a) With the help of a flow-chart explain the fast decoupled load flow using 18-1V scheme. Mention and justify the assumptions made in arriving at the decoupled and simplified set of equations.

1(b) The $A_b$, $A_t$ and $K$ matrices of a three bus power system network are as follows:

$$
A_b = \begin{bmatrix}
-1 & 0 & 0 \\
0 & -1 & 0 \\
1 & 0 & -1 \\
\end{bmatrix} \quad A_t = \begin{bmatrix}
1 & -1 & 0 \\
0 & 1 & 1 \\
\end{bmatrix} \quad K = \begin{bmatrix}
-1 & 0 & -1 \\
0 & -1 & 0 \\
0 & 0 & -1 \\
\end{bmatrix}
$$

Form matrices $B$ and $C$ for the power system network.

2(a) Obtain $Z^{0,1,2}_{pr}$ from the knowledge of $Z^{a,b,c}_{pq}$ for a rotating element of power systems. Why the three sequence impedances are different from one another, give physical reasoning.

2(b) The expression for the fault current in symmetrical components is given as:

$$
I^{0,1,2}_{pp} = \frac{\sqrt{3}E^{a}_{p(0)}}{2Z_{f} + Z^{(1)}_{pp} + Z^{(2)}_{pp} + Z^{(0)}_{pp}} \begin{bmatrix}
1 \\
1 \\
1 \\
\end{bmatrix}
$$

For a fault at bus # 2, calculate fault current in phase coordinates and mention type of the fault. Data in per unit are:

$Z^{(0)}_{22} = j0.03; \quad Z^{(1)}_{22} = Z^{(2)}_{22} = j0.08; \quad Z_{f} = j0.02; \quad E^{a}_{2(0)} = 1.05\angle 4^\circ.$

3(a) Give a detailed account of various methods of static VAR compensation for voltage control in an interconnected power system.

3(b) A 3-phase 275 kV transmission line has the line constants as: $A = D = 0.90\angle 2.5^\circ$, $B = 150\angle 85^\circ$ ohms and $C = 0.35\angle 90^\circ$ milli-siemes. The line is delivering a load of 250 MW at 0.9 power factor lagging at 275 kV, determine the type and value of shunt compensation required to maintain the sending voltage at 275 kV. If the load is removed, what will be the receiving end voltage?

-OR-

3'(a) What are the objectives of Automatic Generation Control in an interconnected power system? A 500 MW synchronous generator is supplying a load of 400 MW. If the change in load is 1% with 1% change in frequency, calculate the constant $b$ in per unit MW/Hz.

Contd.......2
3(b) The simplified transfer function of a single area AGC with free governor action is:

\[ \Delta F(s) = - \frac{K_{PS}}{(1 + K_{PS}/R) + s \tau_{PS}} \Delta P_D(s) \]

Obtain expression for the time response \( \Delta f(t) \) for a step input in load demand. Calculate the steady state frequency error for:

\[ \Delta P_D = 0.02 \text{ p.u.}; \quad K_{PS} = 100; \quad \tau_{PS} = 25 \text{ sec} \quad \text{and} \quad R = 2.5 \text{ Hz/MW} \]

4(a) Discuss the advantages of Optimal Power Flow over classical Economic Dispatch.

4(b) Derive expression for incremental transmission loss (ITL) for \( i^{th} \) plant, if the generalized loss formula is given as:

\[ P_L = P_o B P_o + B_c P_o + B_{oo} \]

4(c) A steam plant and a hydro plant supply an area jointly. The hydro plant runs for 16 hours a day and the steam plant runs throughout the day. The characteristics of the plants are:

\[ C_s = 6 + 15 P_s + 0.05 P_s^2 \quad \text{Rs/hour and} \quad Q_h = 28 P_h + 0.03 P_h^2 \quad \text{m}^3/\text{sec} \]

The load on the steam plant, when both plants are in operation, is 350 MW and the water consumed by the hydro plant during 16 hours is 450 million \( \text{m}^3 \). Calculate the hydro generation and cost associated with incremental water rate. Assume that load on hydro plant is constant for 16 hours.

-OR-

4(c') A steam plant and a hydro plant are operating in parallel and feeding a common load. The characteristic of the plants and the daily load curve are:

\[ C_s = 100 + 20 P_s + 0.02 P_s^2 \quad \text{Rs/hour and} \quad Q_h = 16 + 30 P_h \quad \text{m}^3/\text{sec} \]

If the energy generated by hydro plant per day is 4000 MWhr, what is the minimum cost of operation of the steam plant per day? Also calculate the cost associated with incremental water rate.

5(a) What is meant by contingency analysis? Describe various states of power system operation after the occurrence of a contingency. How contingency analysis is helpful in security assessment of a power system?

5(b) How 'network outages' are considered in contingency analysis?

-OR-

5(b') Explain the weighted least square estimation technique for state-estimation in an interconnected power system.
1. (a) Show that the phase variable representation yields a completely controllable state model for all values of $a_{i_s}$. Where $a_{i_s}$ are the coefficients of characteristic equation. (4)

(b) Using state model representation, determine the transfer function of the system shown in figure 1. Where $x_1$, $x_2$ and $x_3$ constitutes the state vector. (8)

OR

1'. (a) The state model of a system is given by:
\[ \dot{x} = \begin{bmatrix} 1 & 3 \\ -4 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 3 \end{bmatrix} u \\
Y = \begin{bmatrix} 1 & 4 \end{bmatrix} x \]

Determine a state model for this system in which the system matrix is a diagonal matrix. (5)

(b) For a speed control system the plant model is given as:
\[ \dot{x} = \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\
Y = \begin{bmatrix} 1 & 4 \end{bmatrix} x \]

Determine the response of the system to a unit step input under zero initial conditions. (7)

2. (a) Describe an ideal sampler. (1)

(b) Find the pulse transfer function of the system shown in fig.2. (3)

(c) For the sampled data system shown in fig. 3 find the output when the input is:
(i) unit step  (ii) unit impulse (8)

3. (a) Examine the stability of the following characteristic equation using Jury’s stability criterion.
\[ D(z) = 2z^4 + 7z^3 + 10z^2 + 4z + 1 \]

(b) The closed loop transfer function of system is given as ; (6)
\[ T(z) = \frac{3z^2 - 2z + 8}{z^3 + 0.5z^2 - 0.25z + 0.75} \]

Develop two different state models for it.

OR

3'. (a) Discuss various configurations for implementing a digital controller.  
(b) Examine the stability of the following characteristic equation using Bilinear transformation.
\[ D(z) = 2z^4 + 7z^3 + 10z^2 + 4z + 1 \]

4. (a) Show that complete controllability is the necessary requirement for full state feedback.
(b) A system is represented by its state model as
\[
\begin{bmatrix}
0 & 1 & 0 \\
0 & 0 & 1 \\
-5 & -7 & -3
\end{bmatrix}
\begin{bmatrix}
x \\
x \\
y
\end{bmatrix} +
\begin{bmatrix}
0 \\
0 \\
1
\end{bmatrix} u
\]
\[ y = [-2 \ 4 \ 3] x \]

It is desired to place the close loop poles at \( S = -4, -4, \) and \(-5\). Find the required state feedback gain matrix.
(c) Discuss the role of observer in the design of control systems. What are the conditions to be satisfied for the successful design of an observer? Also explain the concept of a reduced order observer.

5. (a) Discuss the significance of Describing Function as a linearization technique. Also derive the describing function of a relay with dead zone.
(b) Consider the system
\[ \ddot{y} + 3 \dot{y} + 2y = 0 \]
Check the stability of the system using a suitable Liapunov's function.

OR

5'. (a) With the help of suitable examples differentiate between:
(i) Incidental and intentional non linearity (ii) Soft and hard non linearity (iii) Positive definite and positive semi definite function (iv) Local and global stability
(b) Draw the phase trajectories for the system shown in fig. 4.
Given: \( r(t) = 2 \ u(t), \ c(0) = -2, \dot{c}(0) = 0 \)

FIGURES ENCLOSED
Maximum Marks: 60
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Answer all the questions.
Assume suitable data if missing.
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Q.No. Question

1(a) Explain any two mechanisms by which breakdown occur in commercial liquid dielectrics. [06]

1(b) What are the limitations of Townsend's theory? With suitable figures, explain Streamer theory for breakdown of gases under uniform field. OR

1'(a) Enumerate various ionization processes responsible for breakdown in gases. Define Townsend's first and second ionization coefficients. [05]

1'(b) Explain in detail the breakdown phenomena in electronegative gases and develop the condition for breakdown of such gases under uniform field. [07]

2(a) What are the characteristics of a testing transformer? What are the different types of tests performed by the testing transformer? [05]

2(b) With a neat diagram, explain the principle of operation of a 3-stage cascaded transformer connection for very high a.c. voltage generation. What are the advantages and disadvantages of using such scheme? OR

2'(a) With a suitable diagram, explain in detail the generation of high frequency high voltages using tesla coil. [06]

2'(b) Explain the principle of Chubb-Frotscue method for peak voltage measurement. Discuss its advantages and limitations for high voltage measurement. [06]

3(a) With suitable sketches, explain the principle of measurement of high voltages using Sphere Gap. Why correction factor is incorporated in this method? [07]
3(b) Describe with a neat sketch, the working of a Van de Graaff generator. [05]

OR

3'(a) Explain the working of a Cockcroft-Walton type voltage multiplier circuit for generation of high d.c. voltages. [06]

3'(b) With the help of suitable diagram, explain the principle of generating voltmeter. Discuss its advantages and limitations for high voltage measurement. [06]

4(a) Define standard lightning impulse and switching surges as per Indian standards. Develop the expression for output voltage of a basic Marks circuit. [06]

4(b) Explain the principle of potential dividers used for high voltage impulse measurement. What is the purpose of delay cable used in this method? [06]

5(a) Give the temperature classification of solid insulating materials with two examples of each. [04]

5(b) What are partial discharges? Develop an expression for Partial Discharge Inception Voltage in voids. [05]

5(c) Define Basic Impulse Insulation Level. [03]
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) Calculate the number of daylight hours (sunshine hours) in Srinagar on January 1 and July 1. The latitude of Srinagar is 34° 05' N. 

\[ T_d = \frac{2}{15} \cos^2 \left[-\tan (\theta) \tan (\delta)\right] \] 

1(b) What are renewable energy resources? Explain the importance of renewable energy sources in the context of global warming.

OR

1'(a) Explain the working of solar passive space heating and cooling system with the help of suitable diagrams.

1'(b) Classify different energy sources based on different parameters such as origin and commercial application. Draw the block diagram of energy chain.

2(a) Draw and explain the equivalent circuit of a practical solar PV cell.

2(b) A PV system feeds a dc motor to produce 1 hp power at the shaft. The motor efficiency is 85%. Each module has 36 multicrystalline silicon solar cells arranged in a 9x4 matrix. The cell size is 125 mm x 125 mm and the cell efficiency is 14%. Calculate the number of modules required in the PC array. Assume global radiation incident normally to the panel as 1kW / m².

3(a) Classify different types of Bio-gas Plant and briefly explain any one of them with

Contd.......2
suitable diagram.

3(b) Calculate the volume of a cow-dung based biogas plant required for cooking needs of a family of five adults and lighting needs with two 100 cp lamps for five hours daily. Also, calculate the required number of cows to feed the plant. Assume standard values of data where required.

[Gas required for cooking per person = 0.227 m$^3$/day. Gas required for lighting for 100cp lamps per hour = 0.126 m$^3$/day. Collectable cow dung per day = 7kg/day. Weight of dry solid mass in cow dung = 18% Slurry density = 1090 kg/ m$^3$. Cow dung gas yield = 0.34 m$^3$/kg of dry matter. 95% volume is occupied by the slurry.]

OR

3'(a) Describe any four common fuel used in fuel cell and write their relevant chemical reactions.

3'(b) Draw and discuss VI characteristics of a fuel cell and define various types of polarizations.

4(a) A propeller-type wind turbine has the following data:

- Speed of free wind at a height of 10m = 12 m/s
- Air density = 1.226 kg/m$^3$
- $\alpha = 0.14$
- Height of tower = 100m
- Diameter of rotor = 80m
- Wind velocity at the turbine reduces by 20%, generator efficiency = 90%

Find
- Total power available in wind
- Power extracted by the turbine
- Electrical power generated
- Axial thrust on the turbine
- Maximum axial thrust on the turbine

4(b) Discuss the limitations of MHD systems and explain open-cycle MHD generating system with the help of schematic diagram.

5(a) A single-basin-type tidal power plant has a basin area of 3 km$^2$. The tide has an average range of 10m. Power is generated during flood cycle only. The turbine stops operating when the head on it falls below 3 m. Calculate the average power generated by the plant in a single filling process of the basin if the turbine-generator efficiency is 0.65. Estimate the average annual energy generation of the plant.

5(b) Write the advantages of wave energy. Classify different types of wave energy technology and explain any one of them with suitable diagram.
Q.No.  

1(a) Show that the inverse Fourier transform of \( \text{rect}\left[\frac{2\pi f-10}{2\pi}\right] \) is \( \text{sinc}(\pi t)e^{j10t} \).  

1(b) State and prove the sampling theorem.  

1(c) Write a short note on communication channels and their characteristics.  

2(a) Consider a message signal \( m(t) \) with the spectrum shown in Fig. 1. The message bandwidth \( W=1\text{kHz} \). This signal is applied to a product modulator, together with a carrier wave \( A_c \cos 2\pi f_c t \), producing the DSB-SC modulated signal \( s(t) \). The modulated signal is next applied to a coherent detector. Assuming perfect synchronism between the carrier waves in the modulator and detector, determine the spectrum of the detector output when: (a) the carrier frequency \( f_c=1.25\text{kHz} \) and (b) the carrier frequency \( f_c=0.75\text{kHz} \). What is the lowest carrier frequency for which each component of the modulated signal \( s(t) \) is uniquely determined by \( m(t) \)?

2(b) Define angle modulation. Also explain how a frequency modulator can be

Fig. 1.
converted to a phase modulator and vice versa.

2(c) What are the four most common methods of pulse modulation? Which method among these is the only form of pulse modulation that is used in the digital transmission system? Explain.

3(a) What are the desirable properties of a line code? Explain. A random binary data sequence 110100101 is transmitted by using a Manchester line code. Sketch the waveform of transmitted signal.

3(b) For the DPSK modulator having XOR gate, determine the output phase sequence for the following input bit sequence: 00110011010101 (assume that the reference bit=1).

3(c) A signal $m(t)$ band limited to 3kHz is sampled at a rate 33% higher than Nyquist rate. The maximum acceptable quantization error is 0.5% of peak amplitude $m_p$. The quantized samples are binary coded. Find the minimum bandwidth of a channel required to transmit the encoded binary signal. If 24 such signals are time division multiplexed, determine the minimum bandwidth required to transmit the multiplexed signal.

OR

3'(a) What is the main disadvantage of uniform quantization and how it can be removed using non-uniform quantization? Explain.

3'(b) Obtain the Lempel-Ziv code of sequence: 11010010110. Recover the original sequence from the encoded stream.

3'(c) Explain the differential pulse code modulation (DPCM) scheme with proper block diagram.

4(a) List the important features of a cellular mobile system.

4(b) Define the following terms in context of optical fiber communication:
- Total internal reflection
- Acceptance angle
- Acceptance cone

4(c) List the advantages and disadvantages of satellite communication system. Why uplink frequency is higher than downlink frequency?

OR

4'(a) Explain the functions of different elements of a cellular mobile system

4'(b) Briefly discuss the important features of a computer communication network.

4'(c) Write a short note on public switched telephone network.