

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019**

**Course Code: EE302**

**Course Name: ELECTROMAGNETICS**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |  |     |
|---|--|-----|
| 1 | Find the divergence of $\vec{A}$ where $\vec{A} = \rho z \sin \phi \vec{a}_\rho + 3\rho z^2 \cos \phi \vec{a}_\phi$  | (5) |
| 2 | Define equipotential surface?  | (5) |
| 3 | Explain Biot-Savart Law.   | (5) |
| 4 | Derive Maxwell's equations in differential and integral form from Faraday's Law  | (5) |
| 5 | What is displacement current?  | (5) |
| 6 | Apply Poynting theorem to derive an expression for power flowing through a co-axial cable  | (5) |
| 7 | Compute the phase constant and attenuation constant for a uniform plane wave having frequency 10GHz in a lossy dielectric material for which $\mu = \mu_0$ , $\epsilon_r = 2.3$ and $\sigma = 2.56 \times 10^{-4} \text{ S/m}$ . | (5) |
| 8 | What is electromagnetic interference? What are its causes?   | (5) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- |    |  |     |
|----|--|-----|
| 9  | a) State and Prove Stoke's Theorem   | (5) |
|    | b) What is Curl of a vector field? Explain its physical significance.  | (5) |
| 10 | a) State and Prove Gauss's law.  | (5) |
|    | b) Apply Gauss's law to find the expression for Electric field Intensity and Electric flux density due an infinite line charge distribution. | (5) |
| 11 | a) Explain the concept of electric potential and potential gradient.   | (5) |
|    | b) Explain spherical co-ordinate system.   | (5) |

**PART C**

*Answer any two full questions, each carries 10 marks.*

- 12 a) Apply Biot-Savart law and determine an expression for magnetic field intensity at a point due to an infinitely long straight conductor carrying current I. (7)
- b) Explain continuity equation for current. (3)
- 13 a) State Ampere's circuital law and explain any one application of Ampere's circuital law (5)
- b) Derive the boundary conditions with respect to the electric field at the interface of a dielectric – dielectric boundary (5)
- 14 a) Derive an expression for energy stored in an electrostatic field in terms of electric flux density. (7)
- b) What is electric polarisation? Explain. (3)

**PART D**

*Answer any two full questions, each carries 10 marks.*

- 15 State and explain Poynting theorem and Poynting vector. Also derive an expression for average power density. (10)
- 16 a) A uniform plane wave is travelling at a velocity of  $2.5 \times 10^5$  m/s having wavelength  $\lambda = 0.25$ mm in a non magnetic good conductor. Calculate the frequency of wave and the conductivity of a medium. (5)
- b) What are electromagnetic waves? Explain the concept of uniform plane waves. (5)
- 17 Derive the wave equations for a transmission line. (10)

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Reg No.:\_\_\_\_\_

Name:\_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B. TECH DEGREE EXAMINATION(S), DECEMBER 2019**

**Course Code: EE302**

**Course Name: ELECTROMAGNETICS**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |   |     |
|---|---|-----|
| 1 | Explain the physical significance of Divergence of a vector field.  | (5) |
| 2 | Two-point charges of 20nC and -20nC are located at (1,0,0) and (0,1,0) respectively in free space. Calculate the electric field intensity at (0,0,1). | (5) |
| 3 | State and prove Ampere's Circuital law.   | (5) |
| 4 | Explain Electric Polarization.  | (5) |
| 5 | What is meant by uniform plane waves? Also, why are electromagnetic waves called as transverse electromagnetic waves?                                 | (5) |
| 6 | Explain Poynting vector and Poynting theorem.   | (5) |
| 7 | Explain skin depth and obtain an expression for it.   | (5) |
| 8 | Explain characteristic impedance and standing wave ratio of transmission line.  | (5) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- |       |  |      |
|-------|--|------|
| 9     | Verify divergence theorem for the vector field $\vec{H} = 2\rho Z^2 \vec{a}_\rho + \rho \cos^2 \phi \vec{a}_Z$ over the surface defined by $\rho = 2$ , $0 < Z < 2$ , $0 \leq \phi \leq 2\pi$ .  | (10) |
| 10 a) | A vector field $\vec{E} = \frac{100 \cos \theta}{\rho^3} \vec{a}_\rho + \frac{50 \sin \theta}{\rho^3} \vec{a}_\theta$ at a point with spherical coordinates $(2, \frac{\pi}{3}, \frac{\pi}{9})$ . Find (i) Magnitude of $\vec{E}$ (ii) Unit vector in cartesian coordinate in the direction of $\vec{E}$ . | (6)  |
| b)    | Explain Equipotential surface.   | (4)  |
| 11 a) | Derive the expression of Electric field intensity due to infinite line charge having line charge density $\rho_L$ C/m.   | (6)  |
| b)    | Derive Laplace's equation for electrostatic field.   | (4)  |

**PART C**

*Answer any two full questions, each carries 10 marks.*

- |       |   |      |
|-------|---|------|
| 12    | Derive Maxwell's equations in integral form and point form.                     | (10) |
| 13 a) | A circular loop of radius 'a' m is carrying a current of I A. Find the magnetic | (6)  |

field intensity at a point 'h' m from the loop along its axis.

- b) Explain magnetic scalar and vector potential. (4)
- 14 a) Derive Continuity equation. (3)
- b) Explain displacement current density. Obtain the dielectric-dielectric boundary conditions for electric fields. (7)

#### PART D

*Answer any two full questions, each carries 10 marks.*

- 15 Derive wave equation from Maxwell's equation for a plane wave in a perfect dielectric. (10)
- 16 Explain power flow in a co-axial cable using poynting theorem. (10)
- 17 a) Explain very briefly about Electromagnetic Interference and Electromagnetic compatibility. (2)
- b) A 180 MHz plane wave is travelling in a medium characterized by  $\mu_r = 1$ ,  $\epsilon_r = 25$ , and  $\sigma = 2.5 \frac{mS}{m}$ . Find (i) intrinsic impedance (ii) Attenuation constant (iii) Propagation constant (iv) Skin depth. (8)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Sixth semester B.Tech examinations (S), September 2020

**Course Code: EE302****Course Name: ELECTROMAGNETICS**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

- 1 Given the two points A (2, 3,-1) and B (4, 25<sup>0</sup>, 120<sup>0</sup>). Find the Spherical coordinates of A and Cartesian coordinates of B. (5)
- 2 Obtain Poisson's equation from Gauss's law (5)
- 3 Explain (i) scalar magnetic potential and (ii) vector magnetic potential (5)
- 4 Show that the displacement current through a parallel plate capacitor is equal to the conduction current  $I$  flowing in the external circuit. (5)
- 5 A coaxial cable carries a dc voltage  $V$  and current  $I$ . Show that the power flow is  $VI$  using Poynting's theorem. (5)
- 6 In a transverse electromagnetic wave, electric field intensity is given by  $\mathbf{E} = E_m \sin(\omega t - \beta z) \mathbf{a}_y$  in free space, Sketch  $\mathbf{E}$  and  $\mathbf{H}$  at  $t=0$ . (5)
- 7 Derive the expressions for attenuation constant and phase constant for a uniform plane wave propagating in a conducting medium. (5)
- 8 In a non-magnetic medium, electric field intensity is  $\mathbf{E} = 4 \sin(2\pi \times 10^7 t - 0.8x) \mathbf{a}_z$  V/m. Find the relative permittivity and intrinsic impedance of the medium. (5)

**PART B***Answer any two full questions, each carries 10 marks.*

- 9 a) Define divergence of a vector field. Explain its physical significance. (4)  
b) Transform the vector  $\mathbf{F} = \frac{1}{r} \mathbf{a}_r$  in spherical coordinates into a vector in Cartesian coordinates. (6)
- 10 a) State and prove Stokes theorem. (5)  
b) What is an electric dipole? Derive an expression for the electric field intensity at any point due to dipole. (5)
- 11 a) State Gauss's law. Using Gauss's law, derive an expression for electric field intensity due to an infinite plane sheet of charge. (6)

- b) If the electric potential in a region is given by,  $V = 2x^2y + 20z - \frac{4}{x^2+y^2}$  volts. (4)  
Find electric field intensity and electric flux density at P (6, -2.5, 3).

### PART C

*Answer any two full questions, each carries 10 marks.*

- 12 a) Consider an infinitely long straight conductor carrying current I. Calculate the magnitude of magnetic flux density at a distance r from the conductor assuming the permeability of the medium to be equal to  $\mu$  (5)
- b) A square loop of side 10 cm centered at the origin carries 100A in the counter clockwise direction. Calculate the magnetic field intensity at the centre of the loop. (5)
- 13 a) A circular loop located on  $x^2 + y^2 = 9, z = 0$ , carries a direct current of 10A along  $\mathbf{a}_\Phi$ . Determine the magnetic field intensity,  $\mathbf{H}$  at (0, 0, 4). (6)
- b) Derive the expression for electrostatic energy stored in an assembly of N point charges. (4)
- 14 a) Derive the electrostatic boundary conditions at the interface between two perfect dielectrics. (6)
- b) Explain the inconsistency of Ampere's circuital law for time varying fields. (4)

### PART D

*Answer any two full questions, each carries 10 marks.*

- 15 State and prove Poynting's theorem and explain the physical significance of Poynting's vector. (10)
- 16 a) Derive the wave equation for electric field in phasor form. (5)
- b) Calculate the skin depth and wave velocity at 2 MHz in aluminium with conductivity  $40 \times 10^6 \Omega^{-1}\text{m}^{-1}$  and relative permeability,  $\mu_r=1$ . (5)
- 17 a) A transmission line has  $R=30\Omega/\text{km}$ ,  $L=100\text{mH}/\text{km}$ ,  $G=0$  and  $C=20\mu\text{F}/\text{km}$ . At a frequency of 1 kHz, calculate the characteristic impedance and propagation constant of the line. (6)
- b) Define standing wave ratio. How is it related to voltage reflection coefficient? (4)

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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019**

**Course Code: EE304**

**Course Name: ADVANCED CONTROL THEORY**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |  |     |
|---|--|-----|
| 1 | Compare the effects of P, PI and PID controllers on the closed loop system performance in terms of rise time, peak overshoot, settling time, steady state error and stability. | (5) |
| 2 | What are the effects of Lag and Lead compensators on the system performance?   | (5) |
| 3 | Explain the terms (i) state (ii) state variables (iii) state vector (iv) state space (v) state trajectory of a system.   | (5) |
| 4 | What is pulse transfer function? Derive the transfer function of a ZOH circuit.  | (5) |
| 5 | State any five characteristics of Nonlinear systems.   | (5) |
| 6 | Define Describing function. Explain how describing function can be used for stability analysis of nonlinear systems.   | (5) |
| 7 | Define Singular point. Explain the nature of Eigen values of system matrix for any five types of singular points.  | (5) |
| 8 | Explain Liapunov second method of stability for nonlinear systems.   | (5) |

**PART B**

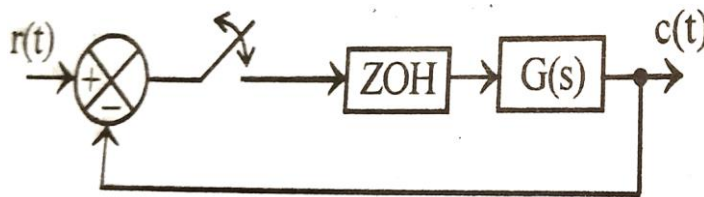
*Answer any two full questions, each carries 10 marks.*

- |    |   |      |
|----|---|------|
| 9  | A unity feedback system has an open loop transfer function $G(S) = K/[S(1+2S)]$ . Design a suitable lag compensator so that phase margin is $40^\circ$ and the velocity error constant is 5.  | (10) |
| 10 | Design a lead compensator for a unity feedback system with open loop transfer function $G(S) = K/[S(S+8)]$ to satisfy the following specifications. (1) Percentage overshoot = 9.5% (2) Natural frequency of oscillation = 12 rad/sec (3) Velocity error constant $\geq 10$ . | (10) |
| 11 | a) Explain the Ziegler-Nichols method of tuning a PID controller.   | (6)  |
|    | b) What is meant by series compensation and feedback compensation in control systems?   | (4)  |

**PART C**

*Answer any two full questions, each carries 10 marks.*

- 12 a) Define controllability and observability of a system and check whether the system  $\frac{Y(s)}{U(s)} = \frac{1}{(s+1)(s+2)}$  is controllable or not. (6)
- b) Check the stability of the sampled data control system shown below (4)
- $$z^3 - 0.2z^2 - 0.25z + 0.05 = 0$$
- 13 Determine the pulse transfer function of the discrete time control system shown in figure for a sampling time of  $T=1$  sec. Also find the response to unit step input. The transfer function of the system is  $G(s) = 1/(s+1)$ . (10)

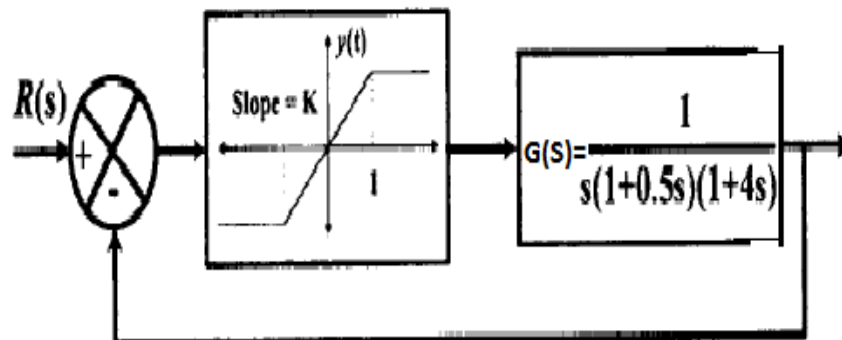


- 14 a) Derive the state model of an R-L-C series circuit (3)
- b) Consider a linear system described by the transfer function  $Y(s)/U(s) = 10/[S(S+1)(S+2)]$ . Design a feedback controller with a state feedback so that the closed loop poles are placed at  $-2, -1 \pm j1$ . (7)

### PART D

*Answer any two full questions, each carries 10 marks.*

- 15 Derive the Describing function of saturation with Dead-zone nonlinearity. (10)
- 16 Consider a unity feedback system shown in figure having a saturating amplifier with a gain K. Determine the maximum value of K for the system to be stable. What would be the frequency and nature of limit cycle for a gain of  $K=2.5$ ? (10)



- 17 A linear second order system is described by the equation  $\ddot{e} + 2\delta\omega_n\dot{e} + \omega_n^2e = 0$  (10)



Where  $\delta = 0.15$ ,  $\omega_n = 1\text{rad/sec}$ ,  $e(0)=1.5$ , and  $\dot{e}(0) = 0$

Determine the singular point and state the stability by constructing the phase trajectory using the method of isoclines.

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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019**

**Course Code: EE304**

**Course Name: ADVANCED CONTROL THEORY**

Max. Marks: 100

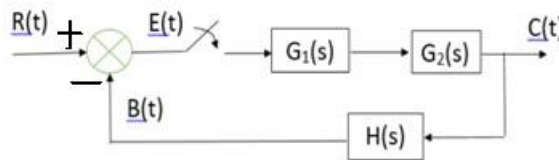
Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |  |     |
|---|--|-----|
| 1 | Obtain the transfer function of a lead compensator with the help of an electrical network. | (5) |
| 2 | Derive the transfer function of a PID Controller   | (5) |
| 3 | Derive a relation between state equation and transfer function for LTI system.             | (5) |
| 4 | Obtain the pulse transfer function for the system shown below.                             | (5) |



- |   |   |     |
|---|---|-----|
| 5 | With a neat diagram explain how the describing function analysis is used to determine the stability of a system?                | (5) |
| 6 | What are jump response and limit cycles in connection with nonlinear systems?   | (5) |
| 7 | Explain with neat diagram, what is phase trajectory and phase portrait?   | (5) |
| 8 | Define positive definite and positive semi definite functions according to Liapunov stability criteria, with suitable examples. | (5) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- |    |  |      |
|----|--|------|
| 9  | a) Draw the bode-plot of lag compensator and obtain an expression for maximum phase lag and corresponding frequency. | (6)  |
|    | b) Explain tuning of PID controller using Ziegler-Nichols tuning method.   | (4)  |
| 10 | Explain the procedure for design of a lag Compensator using Bode Plot with suitable example                          | (10) |
| 11 | Consider a unity feedback system with open loop transfer function  | (10) |

$$G(s) = \frac{k}{s(s+8)}$$

Design a lead compensator to meet the following specification:

1. Percentage peak overshoot is 9.5%
2. Natural frequency of oscillations 12 rad/sec
3. Velocity error constant  $\geq 10$

**PART C**

*Answer any two full questions, each carries 10 marks.*

- 12 a) A system is described by  $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} x(t)$  (5)

Determine state transition matrix for the system.

- b) Define controllability. Explain with a suitable example, how can we check the controllability of a system? (5)

- 13 Derive the state model of the following transfer function in, (10)

(i) Controllable canonical form

(ii) Diagonal canonical form

$$\frac{y(s)}{u(s)} = \frac{5(s+2)}{s(s+1)(s+3)}$$

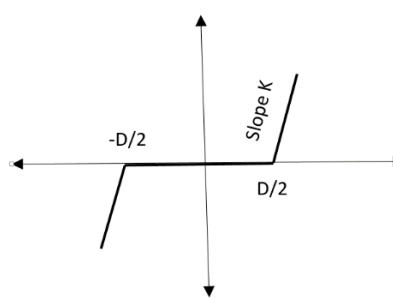
- 14 Examine the stability of the system with the following characteristic equation (10)  
using Jury's stability test.

$$z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$$

**PART D**

*Answer any two full questions, each carries 10 marks.*

- 15 Identify the following non linearity and derive a describing function for the same (10)



- 16 Consider the following non linear differential equation. (10)

$$\ddot{y} - \left(0.1 - \frac{10}{3}\dot{y}^2\right)\dot{y} + y + y^2 = 0$$

Find all singular points of the system, classify them and sketch the phase portrait in the neighbourhood of singular points.

- 17 a) Discuss any three non linearities present in nature. (6)

- b) Investigate the stability of the following non-linear system using Liapunov direct method (4)

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -x_1 - x_1^2 x_2.$$

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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Sixth semester B.Tech examinations (S), September 2020

**Course Code: EE304****Course Name: ADVANCED CONTROL THEORY**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

- |   |  |     |
|---|--|-----|
| 1 | What is a PI controller? What are its effects on the system performance?                                       | (5) |
| 2 | What is a lead compensator? Obtain its frequency response characteristics                                      | (5) |
| 3 | What is state space? What are the advantages of state space analysis?  | (5) |
| 4 | What is pulse transfer function? What is the stability criterion of a sampled data control system?             | (5) |
| 5 | Mention any two characteristics of Nonlinear systems. What are limit cycles?                                   | (5) |
| 6 | Define Describing function. What is the difference between stability analysis of linear and nonlinear systems? | (5) |
| 7 | What is the difference between describing function and phase plane method of stability analysis?               | (5) |
| 8 | Explain Liapunov direct method of stability for nonlinear systems.   | (5) |

**PART B***Answer any two full questions, each carries 10 marks.*

- |    |  |      |
|----|--|------|
| 9  | The open loop transfer function of a unity feedback control system is given by $G(S) = K/[S(1+0.5S)(1+0.2S)]$ . It is desired that (i) the steady state error to unit ramp input is less than 0.125 (ii) Phase margin $\geq 30^\circ$ (iii) Gain margin $\geq 10$ db. Design a suitable compensator. | (10) |
| 10 | Design a suitable compensator for a unity feedback system with open loop transfer function $G(S)=K/[S(S+4)(S+7)]$ to satisfy the following specifications. (1)Percentage overshoot=12.63% (2)Natural frequency of oscillation=8 rad/sec(3)Velocity error constant $\geq 2.5$ .                       | (10) |
| 11 | Explain the Ziegler-Nichols method of tuning a PID controller when (a) dynamic model is known (b) dynamic model is not known.  | (10) |

**PART C***Answer any two full questions, each carries 10 marks.*

- 12 a) Obtain the state model of the system whose transfer function is given by (5)  
 $Y(s)/U(s) = 10/[s^3 + 4s^2 + 2s + 1]$
- b) Obtain the state model of a field controlled DC motor. (5)
- 13 A discrete time system is described by the difference equation (10)  
 $y(k+2) + 5y(k+1) + 6y(k) = u(k)$   
 $y(0) = y(1) = 0; T = 1 \text{ sec.}$   
 (a) Determine state model in a canonical form (b) Find the state transition matrix
- 14 Check the stability of the sampled data control system with the following characteristic equation using Jury's stability test  $z^4 - 1.7z^3 + 1.04z^2 - 0.268z + 0.024 = 0$  (10)

**PART D***Answer any two full questions, each carries 10 marks.*

- 15 Derive the Describing function of saturation with deadzone. (10)
- 16 Construct the phase trajectory for the system (10)  
 $\dot{x}_1 = x_2, \dot{x}_2 = -\text{sign}(x_1)$  where  $\text{sign}(x_1) = \begin{cases} 1 & \text{for } x_1 > 0 \\ -1 & \text{for } x_1 \leq 0 \end{cases}$  starting from (2,0)
- 17 Test the stability of the system using Lyapunov stability theorem (10)  
 (a)  $\dot{x}_1 = -x_1 + 2x_1^2x_2, \dot{x}_2 = -x_2$   
 (b)  $\dot{x}_1 = x_2, \dot{x}_2 = -\sin(x_1) - x_2$

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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019**

**Course Code: EE306**

**Course Name: POWER SYSTEM ANALYSIS**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

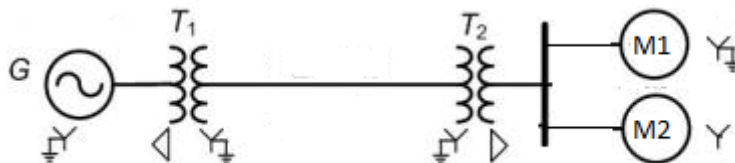
Marks

- |   |  |       |
|---|--|-------|
| 1 | Define the term per unit quantity. Enumerate Merits and Demerits of P.U  | ( 5 ) |
| 2 | What is the significance of current limiting reactors in power system? Where are they located? Give examples.          | ( 5 ) |
| 3 | How slack bus differs from other buses in a power system? What is the significance of slack bus in load flow analysis? | ( 5 ) |
| 4 | What is AVR? What are the functions?   | ( 5 ) |
| 5 | Derive condition for economic load dispatch neglecting losses.   | ( 5 ) |
| 6 | Define penalty factors and loss coefficients in economic operation of power system.                                    | ( 5 ) |
| 7 | Explain the terms 1) steady state stability 2) dynamic stability 3) transient stability                                | ( 5 ) |
| 8 | Write all methods to improve steady state stability limit of power system  | ( 5 ) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- 9 A 300 MVA, 20kV three phase generator has a subtransient reactance of 20%. The generator supplies two synchronous motors over a 64km transmission line having transformers at both ends as shown on the single line diagram. The ratings of the motors are: M1-200MVA, 13.2kV,  $X''=20\%$ ; M2- 100MVA, 13.2kV,  $X''=20\%$ . The ratings of transformers are T1-350MVA, 230/20 kV,  $X=10\%$ ; T2- composed of 3 single phase transformers each rated 127/13.2kV, 100MVA,  $X=10\%$ . Series reactance of the transmission line is 0.5 ohm/km. Draw the reactance diagram with all reactances marked in p.u. Select the generator ratings as base values. ( 10 )



- 10 a) Draw the zero sequence networks of star-delta and delta-delta transformers (5)
- b) Draw and explain the oscillogram of short circuit current when an unloaded alternator is subjected to a 3-phase fault (5)
- 11 Derive the expression for fault current and draw the interconnection of sequence networks for the following faults on the terminals of an unloaded generator. (10)
- (a) single Line to Ground fault
- (b) Line to Line fault

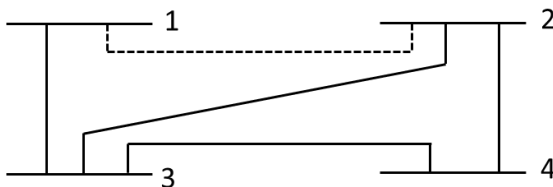
### PART C

*Answer any two full questions, each carries 10 marks.*

- 12 (10)

The figure shows the SLD of a simple four bus system. The table gives the line impedance identified by the buses on which these terminate. The shunt admittance at all the buses is assumed to be negligible.

- a) Find  $Y_{BUS}$ , assuming that the line shown dotted is not connected.
- b) What modifications need to be carried out in  $Y_{BUS}$  if the line shown dotted is connected



Line, Bus to Bus	R pu	X pu
1-2	0.05	0.15
1-3	0.10	0.30
2-3	0.15	0.45
2-4	0.10	0.30
3-4	0.05	0.15

- 13 a) Compare between Gauss-Seidal method and Newton-Raphson method, in load flow studies. (5)
- b) With neat diagram explain the working of a turbine speed governing system. (5)
- 14 Derive the generator load model and draw the complete block diagram of a single area system (10)

**PART D**

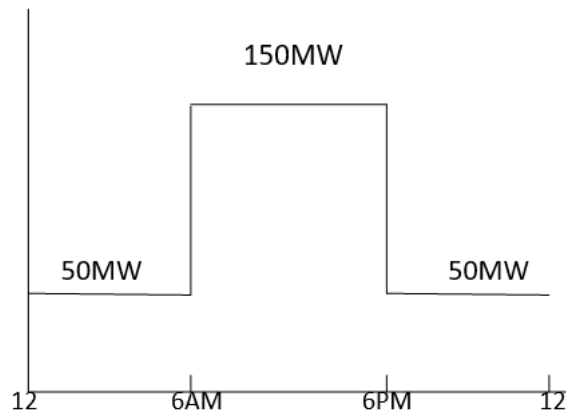
*Answer any two full questions, each carries 10 marks.*

- 15 Assume that the fuel input Btu/hr for units 1 and 2 are given by (10)

$$F_1 = (8P_1 + 0.024P_1^2 + 80)10^6$$

$$F_2 = (6P_2 + 0.04P_2^2 + 120)10^6$$

The maximum and minimum loads on the units are 100MW and 10MW respectively. Determine the minimum cost of generation when the following load is supplied. The cost of fuel is Rs`2/million Btu.



- 16 a) What is the significance of spinning reserve constraint in unit commitment problem? Explain with example. (5)
- b) Explain the equal area criterion to determine the stability of a power system (5)
- 17 a) Derive the swing equation. (5)
- b) A 2 pole 50 Hz, 11kV turbo generator has a rating of 60 MW at 0.85 p.f lagging. (5)
- Its rotor has a moment of inertia of 8800 kg-m<sup>2</sup>. Calculate its inertia constant in MJ/MVA and its angular momentum in MJ-s/elect. Degree.

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Reg No.:\_\_\_\_\_

Name:\_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019**

**Course Code: EE306**

**Course Name: POWER SYSTEM ANALYSIS**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |  |       |
|---|--|-------|
| 1 | Prove that symmetrical components transformation is power invariant.   | ( 5 ) |
| 2 | Explain different types of current limiting reactors   | ( 5 ) |
| 3 | Starting from the first principles, obtain the equations of real power and reactive power used in load flow problem. | ( 5 ) |
| 4 | Derive the block diagram representation of a generator-load model.   | ( 5 ) |
| 5 | How loads are distributed between units within a plant?  | ( 5 ) |
| 6 | What is the significance of thermal unit constraint in unit commitment problem?                                      | ( 5 ) |
| 7 | Derive the swing equation of a synchronous machine?  | ( 5 ) |
| 8 | Draw and explain power angle curve of a synchronous machine?   | ( 5 ) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- |    |  |        |
|----|--|--------|
| 9  | a) How will you draw a reactance diagram when the single line diagram of a power system is given?  | ( 6 )  |
|    | b) A three phase delta-star transformer with a rating of 1000 kVA, 11kV/400V has its primary and secondary leakage reactance as $12\Omega/\text{ph}$ and $0.05\Omega/\text{ph}$ respectively. Calculate the p.u reactance of transformer                           | ( 4 )  |
| 10 | a) The symmetrical components of phase a voltages in a 3-phase unbalanced system are $V_{a0}=10\angle 180^\circ \text{ V}$ , $V_{a1}=50\angle 0^\circ \text{ V}$ and $V_{a2}=20\angle 90^\circ \text{ V}$ . Determine the phase voltages $V_a$ , $V_b$ , and $V_c$ | ( 6 )  |
|    | b) What are the effects of faults in power system? Explain symmetrical fault and why its calculation is necessary?   | ( 4 )  |
| 11 | Derive the expression for fault current and draw the interconnection of sequence networks for double line to ground fault on the terminals of an unloaded generator.   | ( 10 ) |

*Answer any two full questions, each carries 10 marks.*

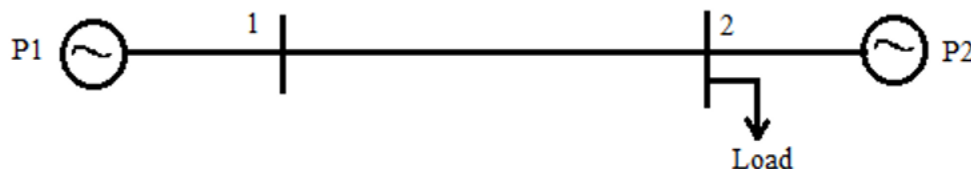
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|----|---|--------|
| 12 | Explain the algorithm for load flow analysis using Newton-Raphson Method. | ( 10 ) |
| 13 | a) Give reasons for :   | ( 5 )  |

- i) Direct solution of load flow problem is not possible.
- ii) Bus admittance matrix is sparse matrix.
- b) A 100MVA synchronous generator operates on full load at frequency of 50 Hz. The load is suddenly reduced by 50 MW. Due to time lag in governor system, the steam valve begins to close after 0.4 s. Determine the change in frequency that occurs in this time. Given  $H = 5 \text{ kW-s/kVA}$ . (5)
- 14 Draw the block diagram representation of Load Frequency Control (LFC) of a single area system & explain the steady state stability for free governor operation ( $\Delta P_c = 0$ ) (10)

### PART D

*Answer any two full questions, each carries 10 marks.*

- 15 A two bus system is shown in figure below. If a load of 125MW is transmitted from plant 1 to the load, a loss of 15.625MW is incurred. Determine the generation schedule and the load demand if the cost of received power is Rs.24/MWhr. Solve the problem using coordination equations and the penalty factor method. The incremental production costs of the plants are: (10)
- $$dF_1/dP_1 = 0.025P_1 + 15$$
- $$dF_2/dP_2 = 0.05P_2 + 20$$



- 16 a) Distinguish between economic dispatch and unit commitment. (5)
- b) Explain the method of solving swing equation by point-by-point method. (5)
- 17 Using equal area criterion, derive an expression for critical clearing angle for a system having a generator feeding an infinite bus through a single circuit line. (10)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Sixth semester B.Tech degree examinations (S), September 2020

**Course Code: EE306****Course Name: POWER SYSTEM ANALYSIS**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

- |   |   |     |
|---|---|-----|
| 1 | Define per unit representation of electrical quantities? List out its advantages.   | (5) |
| 2 | Explain short circuit MVA and its significance in analysing faults in power system.   | (5) |
| 3 | Classify the various types of buses in a power system for load flow studies.  | (5) |
| 4 | Explain the basic generator control loops.  | (5) |
| 5 | Two units have following cost function<br>$F_1 = 120 + 22P_1 + 0.05P_1^2$ Rs/hr<br>$F_2 = 120 + 16P_2 + 0.06P_2^2$ Rs/hr<br>where $P_1$ and $P_2$ in MW. The generator limits are<br>$20 \leq P_1 \leq 100$ MW<br>$20 \leq P_2 \leq 100$ MW<br>Find the economic dispatch for a total demand of 180 MW. | (5) |
| 6 | Explain unit commitment? List out the constraints on unit commitment.   | (5) |
| 7 | Explain the three different stabilities of a power system.  | (5) |
| 8 | Explain critical clearing angle and its significance with respect to the stability of a power system.   | (5) |

**PART B***Answer any two full questions, each carries 10 marks.*

- |   |  |      |
|---|--|------|
| 9 | A 30 MVA, 13.8 KV, 3-phase generator has a sub transient reactance of 15%.<br>The generator supplies 2 motors through a step-up transformer - transmission line – step-down transformer arrangement. The motors have rated inputs of 20 MVA and 10 MVA at 12.8 KV with 20% sub transient reactance each. The 3-phase transformers are rated at 35 MVA, 13.2 KV - $\Delta$ /115 KV-Y with 10 % leakage reactance. The line reactance is 80 ohms. Draw the equivalent per unit reactance diagram by selecting the generator ratings as base values in the generator circuit. | (10) |
|---|--|------|

- 10 a) Explain the significance of symmetrical components in power system. (4)  
 b) Derive the expression for symmetrical components of voltages in terms of phase voltages and hence obtain transformation matrix. (6)
- 11 Derive the expression for fault current and draw the interconnection of sequence networks for line to line fault on the terminals of an unloaded generator. (10)

**PART C***Answer any two full questions, each carries 10 marks.*

- 12 Derive the static load flow equations for a power system. (10)
- 13 a) Write down the steps involved in solving load flow equation using Gauss Siedel method when voltage controlled buses are absent. (7)  
 b) Enumerate the objectives of AGC. (3)
- 14 Develop and explain the block diagram of automatic load frequency control of an isolated power system. (10)

**PART D***Answer any two full questions, each carries 10 marks.*

- 15 a) Derive the expression for economic operation of a plant having different units neglecting transmission losses. (5)  
 b) A 2 bus system consist of two power plants connected by a transmission line. (5)  
 The cost curve characteristics of the two plants are  
 $C_1 = 0.01P_1^2 + 18P_1 + 20 \text{ Rs/hr}$   
 $C_2 = 0.03P_2^2 + 33P_2 + 40 \text{ Rs/hr}$   
 When a power of 120 MW is transmitted from plant 1 to load (near to plant 2), a loss of 16.425 MW is occurred. Determine the optimal scheduling of plants and load demand, if cost of received power is 36 Rs./MWhr.
- 16 a) Explain the steady state limit of a power system with the help of power angle diagram. (3)  
 b) Explain the equal area criterion for assessing the stability of a power system. (4)  
 c) List the methods for improving transient stability of a power system. (3)
- 17 a) Derive the equation for penalty factor for optimal system operation. (5)  
 b) Derive the swing equation representing the rotor dynamics of a synchronous machine. (5)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&amp;S), MAY 2019

**Course Code: EE308****Course Name: Electric Drives**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

- 1 What is an Electric Drive? Explain the function of each blocks with the help of a neat block diagram. (5)
- 2 Explain the armature voltage control and field weakening mode control of DC separately excited motor drive system. (5)
- 3 With a chopper circuit and waveforms explain the regenerative braking of a DC motor drive. (5)
- 4 Explain the speed control method of induction motor with stator voltage and also state the disadvantages of this method. (5)
- 5 Compare CSI fed IM drive with VSI fed IM drive (5)
- 6 Explain the Park's transformation. (5)
- 7 With a block diagram explain the variable frequency control of SM drive in self-control mode. (5)
- 8 Explain the V/F control characteristics in torque-speed plane of a SM drive (5)

**PART B***Answer any two full questions, each carries 10 marks.*

- 9 a) What are the different components of a load torque? Explain each component in detail. (5)  
b) Derive the mathematical condition to obtain the steady state stability of equilibrium point. (5)
- 10 With a neat sketch, explain the motoring and braking operation of three phase fully controlled rectifier control of separately excited DC motor. (10)
- 11 A 200 V, 875 rpm, 150 A separately excited dc motor has an armature resistance of  $0.06\Omega$ . It is fed from a single phase fully controlled rectifier with an ac voltage of 220 V, 50Hz. Assuming continuous conduction, calculate (10)

- (i) Firing angle for rated motor torque and 750 rpm
- (ii) Firing angle for rated motor torque and -500 rpm
- (iii) Motor speed for firing angle  $\alpha=160^\circ$  and rated torque

**PART C**

*Answer any two full questions, each carries 10 marks.*

- 12 Explain the operation of four quadrant chopper fed separately excited DC motor drive with necessary diagrams. (10)
- 13 Explain the closed loop static rotor resistance control method for the speed control of a slip ring induction motor. What are the disadvantages of this method? (10)
- 14 Explain the static Kramer scheme for the speed control of a slip ring IM. Explain the firing angle control of thyristor bridge with constant motor field. (10)

**PART D**

*Answer any two full questions, each carries 10 marks.*

- 15 a) With a neat circuit and waveform explain a thyristor based CSI fed IM drive. (5)  
b) Explain how CSI fed IM drive can be used for regenerative braking and multiquadrant operation. (5)
- 16 a) Explain in detail about the classification of PM synchronous motor? (5)  
b) Explain the field oriented control (FOC) of an AC motor with a block diagram (5)
- 17 With a block diagram explain the Micro controller based PMSM drive. (10)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019**

**Course Code: EE308**

**Course Name: Electric Drives**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer all questions, each carries 5 marks.*

Marks

- |   |  |      |
|---|--|------|
| 1 | What are the functions of power modulator in an electric drive?  | ( 5) |
| 2 | A single phase fully controlled converter is used to control a DC separately excited motor of 200V, 900rpm, 100A with armature resistance of $0.06\Omega$ . AC source voltage is 210V, 50Hz. Determine firing angle for rated motor torque and 700rpm. | ( 5) |
| 3 | With detailed analysis explain how chopper helps to control a separately excited DC motor drive in motoring mode   | ( 5) |
| 4 | How speed of the induction motor can be controlled using stator frequency control.   | ( 5) |
| 5 | Differentiate VSI fed induction motor drive with CSI fed induction motor drive   | ( 5) |
| 6 | Explain field orientation control of induction motors.   | ( 5) |
| 7 | Explain in detail about the different types of PM synchronous motor?   | ( 5) |
| 8 | Explain how speed control can be done in a set of multiple synchronous motors  | ( 5) |

**PART B**

*Answer any two full questions, each carries 10 marks.*

- |    |  |      |
|----|--|------|
| 9  | a) Illustrate four quadrant operation of drive considering hoist as an example   | ( 6) |
|    | b) Draw the Torque – Speed characteristics of the following loads<br>(i) Centrifugal pump (ii) Traction load   | ( 4) |
| 10 | a) With the help of block diagram explain in detail about the closed loop speed control of DC motor  | ( 5) |
|    | b) Draw the armature voltage and armature current waveforms of 3 phase semi-converter-fed DC motor drive for $\alpha=60^\circ$ .                                     | ( 5) |
| 11 | a) Give one application of dual converter for speed control of DC motor.   | ( 5) |
|    | b) A 220V, 1500rpm, 50A separately excited motor with armature resistance of $0.5\Omega$ is fed from a circulating current mode dual converter with a source voltage | ( 5) |

of 165V (line). Determine converter firing angle for the following operating points.

- (i) Motoring operation at rated motor torque and 1000rpm
- (ii) Braking operation at rated motor torque and 1000rpm.

### PART C

*Answer any two full questions, each carries 10 marks.*

- 12 List different types of cycloconverters. Explain single phase step down cycloconverter with circuit diagram and waveforms. (10)
- 13 a) Describe dynamic braking operation of chopper fed separately excited DC motor drive. Draw speed-torque curves in motoring and braking mode (5 )  
b) Describe speed control of induction motors using three phase ac voltage controller. (5)
- 14 What are the slip power recovery control schemes of induction motors. Explain how static Kramer drive is used to control the speed of induction motors. (10)

### PART D

*Answer any two full questions, each carries 10 marks.*

- 15 Discuss the operation of CSI fed induction motor drive. Explain its regenerative braking and multi-quadrant operation. (10 )
- 16 a) Give the concept of basic transformation in reference frame theory applied to induction motors. ( 5 )  
b) Explain in detail about self-control mode of operation of synchronous motor (5 )
- 17 With block diagram, explain the operation of microcontroller based permanent magnet synchronous motor drives. (10 )

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Sixth semester B.Tech degree examinations (S), September 2020

**Course Code: EE308****Course Name: Electric Drives**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

- 1 How are the load torques classified? Give an example for each type of load torque. (5)
- 2 Derive the speed-torque ( $\omega$ -T) equation of a separately excited DC motor. Plot the  $\omega$ -T characteristics of the motor. (5)
- 3 Compare and contrast Class-C and Class-D choppers. (5)
- 4 List and explain the merits of constant V/f control of Induction Motor. (5)
- 5 Explain the differences between the switching devices used for Voltage Source Inverter and Current Source Inverter. (5)
- 6 Write the transformation matrix which converts phasor in three-phase system to an orthogonal, stationary reference frame. (5)
- 7 List down the salient features of “True Synchronous Mode” of operation of a synchronous motor. (5)
- 8 Draw a neat labelled block schematic diagram of microcontroller based Permanent Magnet Synchronous Motor (PMSM) drive. (5)

**PART B***Answer any two full questions, each carries 10 marks.*

- 9 a) A motor-drive system has the following specifications: (5)  
Polar moment of inertia of motor-load system referred to the shaft,  $J = 5 \text{ kg-m}^2$   
Motor torque  $T_m = 50 - 0.1N$ , and Load Torque,  $T_L = 0.025N$   
where, “N” is the speed of the motor in rpm. Calculate the start-up time of the drive.
- b) Draw and explain the closed loop speed control scheme widely used in electric drives. (5)

- 10 a) With neat circuit diagrams and waveforms explain the operation of single phase fully controlled rectifier fed separately excited dc motor. (5)
- b) A 220 V, 1500 rpm, 10 A separately excited motor has an armature resistance of  $2\Omega$ . The motor is driven from a single-phase fully-controlled rectifier operating in continuous conduction mode. The input is rated at 230V, 50Hz. Calculate firing angle of the controlled rectifier if the motor runs at 600 rpm developing rated torque. (5)
- 11 a) Explain the four-quadrant operation of a motor driving a passive load torque. (5)
- b) A 200 V, 20 A, 800 rpm, separately excited DC motor has an armature resistance of  $0.5\Omega$ . The motor drives a load whose torque-speed equation is  $T_L = 5 + 0.05N$ , where “N” is the speed of the motor in rpm. The motor is driven from a single-phase fully controlled rectifier, operating in continuous conduction mode, from an ac source rated at 230V, 50Hz. Find the firing angle of the converter if the motor is operating at 500 rpm. (5)

### PART C

*Answer any two full questions, each carries 10 marks*

- 12 a) With the help of a neat labelled circuit diagram, explain the operation of any one cycloconverter based drive system. (5)
- b) Derive the condition for maximum torque of an induction motor. Also derive the value of the maximum torque the machine can develop. (5)
- 13 a) A 230 V, 90 A, 500 rpm separately excited DC motor has an armature resistance of  $0.15\Omega$ . The motor is controlled by a class-C chopper operating with a source voltage of 230 V and a frequency of 400 Hz. Calculate the motor speed for a braking operation at a duty ratio of 0.4 and half the rated torque. (5)
- b) With necessary diagram, briefly explain the rotor-resistance controlled drive. Draw the Torque – Speed ( $T-\omega$ ) characteristics for different resistances. (5)
- 14 a) A 230 V, 200 A, 960 rpm separately excited DC motor has an armature resistance of  $0.02\Omega$ . The motor is fed from a class-C chopper. The DC input voltage to the chopper is 220 V. Braking method employed is dynamic braking using brake-chopper. The value of the braking resistor used is  $2.5\Omega$ . Find the duty ratio of the brake-chopper if the speed is 700 rpm and braking torque is twice the rated torque of the motor. (5)

- b) With the aid of a neat labelled circuit diagram, explain the operation of any one slip-power-recovery scheme induction motor drive. (5)

### PART D

*Answer any two full questions, each carries 10 marks*

- 15 a) With the help of a neat, labelled circuit diagram, explain the concept of current-source-inverter (CSI) fed induction motor drive. (5)
- b) A 500kW, three-phase, 3.3kV, 4-pole, 0.8 *pf* lag, star connected synchronous motor has following parameters: (5)
- Synchronous reactance  $X_s = 15\Omega$ ; Rotor Resistance  $R_s = 0\Omega$ .  
Calculate the per phase excitation voltage in polar form.
- 16 a) With the help of a neat, labelled circuit diagram, explain the concept of current-source-inverter (CSI) fed induction motor drive. (5)
- b) Explain the reason which facilitates the use of thyristor switches for load commutated inverters to drive synchronous motors. What is the condition to be satisfied for the thyristor based load commutated inverter to work? (5)
- 17 a) Explain Park's Transformation with reference to space vectors. Write down the transformation matrices. (5)
- b) With the help of a neat labelled diagram, explain the working principle, salient features and the advantages of Self Controlled Mode of operation of a Synchronous motor. (5)

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