CBCS SCHEME

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15EE61

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Control System

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Control System. Distinguish between open-loop and closed loop control system with an examples. **(06 Marks)**

b. For the mechanical system shown in Fig.Q1(b), write the differential equation relating to the force F(t). Also obtain the analogous electrical circuits based on i) Force-current analogy ii) Force-voltage analogy. **(10 Marks)**

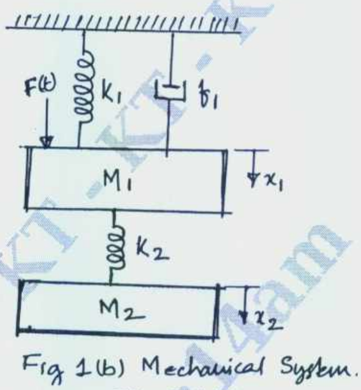

Fig.Q.1(b)

OR

2 a. Define servomotor. Compare AC servomotor and DC servomotor. **(04 Marks)**

b. Derive an expression for the transfer function of an armature controlled D.C. motor and also construct the block diagram of d.c. motor. **(12 Marks)**

Module-2

3 a. For the system represented by the following equations and find the transfer function X(s)/U(s) by the signal flow graph technique.

$$x = x_1 + \alpha_0 u \; ; \; \frac{dx_1}{dt} = -\alpha_1 x_1 + x_2 + \alpha_2 u \; ; \; \frac{du_2}{dt} = -\alpha_2 x_1 + \alpha_1 u$$ **(08 Marks)**

b. Using block diagram reduction technique. Obtain the transfer function of C(s)/R(s) as shown in Fig.Q.3(b). **(08 Marks)**

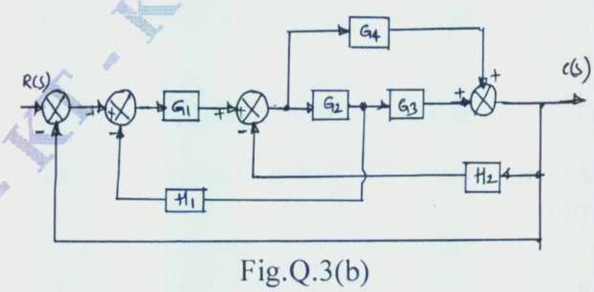

Fig.Q.3(b)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

4 a. State the Mason's gain formula. Find the transfer function $\frac{X_5}{X_1}$ of the system described by the signal flow graph (SFG) shown in Fig.Q.4(a). **(08 Marks)**

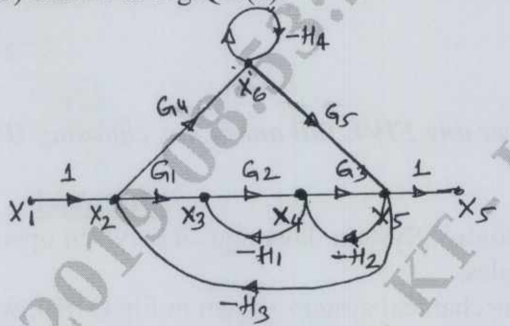

Fig.Q.4(a)

b. For the network shown in Fig.Q.4(b), construct the signal flow graph and determine the transfer function using Mason's gain formula. **(08 Marks)**

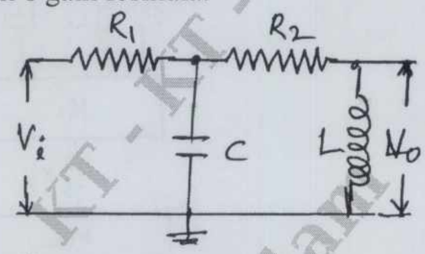

Fig.Q.4(b)

Module-3

5 a. Derive an expression for rise time and peak-time for a second order system excited by a step input (under-damped case). **(08 Marks)**

b. A unity feedback control system is characterized by an open-loop T.F. $G(s) = \frac{K}{s(s+\alpha)}$.

Where K and α are positive constant,
By what factor the amplifier gain K should be reduced so that the peak osvershoot of the unit step response reduces from 75% to 25%. **(08 Marks)**

OR

6 a. A unity feedback system having open-loop T.F. of $G(s) = \frac{K(2s+1)}{S(s+1)(s+1)^2}$. The input $r(t) = 1 + 6t$ is applied to the system. Determine the minimum value of K, if the steady state error is to be less than 0.1. **(04 Marks)**

b. A unity feedback control system has $G(s) = \frac{K(s+4)}{s(s+1)(s+2)}$ using Routh Hurwitz criterion. Find the range of K for which system to be stable and also determine the frequency of oscillations. **(06 Marks)**

c. What are the difficulties encountered while assessing the R-H criteria and how do you eliminate these difficulties? Explain with examples. **(06 Marks)**

Module-4

7 a. What do you means by (i) breakaway point and (ii) break in point. How can they be determined with an example? **(04 Marks)**

b. Sketch the roots locus plot for the system $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$. Determine the range of K for which the system will have damped oscillating response. **(07 Marks)**

c. Show that part of root locus for the open loop T.F. $G(s)H(s) = \frac{K(s+2)}{S(s+1)}$ is a circle. **(05 Marks)**

OR

8 a. Derive an expression for resonant peak and resonant frequency for a second order system. **(06 Marks)**

b. Sketch the Bode-plot for the open-loop transfer function $G(s)H(s) = \frac{K}{s(s+1)(0.1s+1)}$ and determine the value of K for which system is to be stable. Also find the gain margin and phase margin. **(10 Marks)**

Module-5

9 a. State and explain the Nyquist stability criterion. **(06 Marks)**

b. Sketch the Nyquist plot and comment on the stability of the closed loop system whose open-loop transfer function is $G(s)H(s) = \frac{K(s-4)}{(s+1)^2}$. **(10 Marks)**

OR

10 a. Explain the pharse lag compensator with neat circuit diagram and derive expression for the transfer function of a lag compensator. **(06 Marks)**

b. What are the limitations of single stage phase lead control? **(04 Marks)**

c. Write notes on PID controller. **(06 Marks)**

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CBCS SCHEME

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15EE62

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Power System Analysis – I

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define per unit quantity. Mention the advantages of per unit system. **(04 Marks)**

b. Show that the per unit impedance of a transformer remains same whether it is referred to HV or LV winding. **(04 Marks)**

c. A 100MVA, 33KV 3ϕ generator has a subtransient reactance of 15%. The generator supplies 3 motors through a step-up transformer, transmission line, step-down transformer arrangement. The motors have rated inputs of 30MVA, 20MVA and 50MVA at 30KV with 20% subtransient reactance each. The three phase transformers are rated at 100MVA 32KV-Δ/110 KV-Y with 8% leakage reactance. The line has a reactance of 50Ω. By selecting the generator ratings as base in the generator circuit, determine the loose values in all other parts of the system, Hence evaluate the corresponding per unit values and draw the equivalent per unit reactance diagram. (Ref.Fig.Q.1(c)) **(08 Marks)**

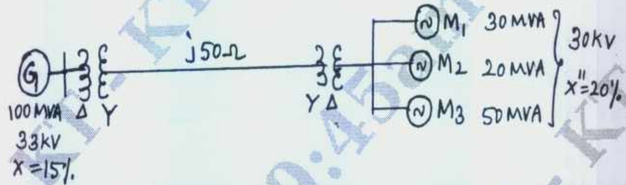


Fig.Q.1(c)

OR

2 a. Draw single line diagram of a power system indicating the various components of it. Obtain the impedance diagram and reactance diagram. Explain each component and the assumptions made to draw the reactance diagram. **(08 Marks)**

b. A 300MVA, 20KV 3 phase generator has a reactance of 20%. The generator supplies two motors M_1 and M_2 over a transmission line of 64KM as shown in one line diagram in Fig.Q.2(b).

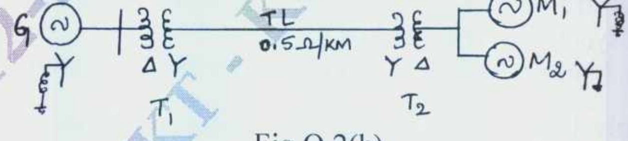


Fig.Q.2(b)

Ratings:

T_1 : 350MVA 230 KV-Y/20KV-Δ, X = 10%

T_2 : Composed of three single phase transformers each rated $\underset{Y}{127}/\underset{\Delta}{13.2}$ KV, 100MVA with reactance of 10%

M_1 : 200MVA, 13.2 KV X″ = j0.2pu

M_2 : 100MVA, 13.2 KV X″ = j0.2pu

Select the generator ratings as base and draw the reactance diagram with all reactances marked in pu. **(08 Marks)**

Module-2

3 a. Explain the transients occurring on a transmission line on the occurrence of a short circuit. Obtain the expression for maximum momentary current. **(06 Marks)**

b. A 25MVA, 11KV generator with $X''_d = 20\%$ is connected through a transformer, line and a transformer to a bus that supplies three identical motors as shown in Fig.Q.3(b). Each motor has $X''_d = 25\%$ and $X'_d = 30\%$ on a base of 5MVA, 6.6KV. The three phase rating of the step-up transformer is 25MVA, 11/66 KV with a leakage reactance of 10% and that of step-down transformer is 25MVA, 66/6.6KV with X = 10%. The bus voltage of the motors is 6.6KV when a three-phase fault occurs at point F. Calculate:

i) The subtransient current in the fault
ii) The subtransient current in the breaker B
iii) The momentary current in breaker B and
iv) The current to be interrupted by breaker B in five cycles.

X of transmission line is 15% on a base of 25MVA, 66KV. Assume that the system is on no load when the fault occurs.

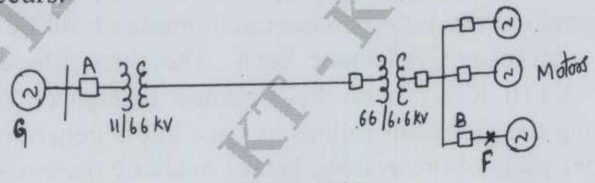


Fig.Q.3(b) **(10 Marks)**

OR

4 a. With the help of oscillogram of short circuit current, of a synchronous generator, operating on no load, distinguish between subtransient, transient and steady state periods. Prove that $X''_d < X'_d < X_d$. **(08 Marks)**

b. A 25MVA, 13.2KV synchronous generator is connected to a synchronous motor of same rating. Both have a transient reactance of 15%. The line connecting them has a reactance of 10% on the machine base. The motor is drawing a power of 18MW at 0.8 pf lead, at 12.9KV, when a short circuit occurs at its terminals, find the subtransient currents in the motor, generator and at fault points. **(08 Marks)**

Module-3

5 a. What are symmetrical components? Obtain the expression for symmetrical components interms of unbalanced phasor of voltages and currents. **(06 Marks)**

b. What are sequence impedances and sequence networks? Explain the sequence impedances of a synchronous generator. **(06 Marks)**

c. In a 3 phase system supplying power to a Y load, the line currents when the neutral of the supply is not connected to the neutral of the load are $I_a = 20\angle 0^\circ$ A and $I_b = 20\angle -100^\circ$ A. When the neutrals are connected, the current through the neutral wire is found to be $12\angle -30^\circ$ A. Determine the line currents under this situation. **(04 Marks)**

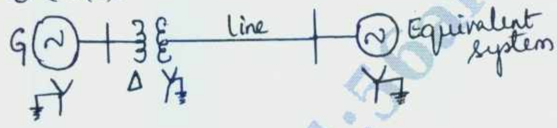
OR

6 a. Determine the relation between the symmetrical components of voltages on either side of a star-delta transformer. **(08 Marks)**

b. Explain the effect of neutral in 3 phase system with 3 wire and four wire. **(04 Marks)**

c. A 250MVA, 11KV, 3 phase generator is connected to a large system through a transformer and a line as shown in Fig.Q.6(c).

Fig.Q.6(c)



The parameters on 250MVA base are as follows:
Generator: $X_1 = X_2 = 0.15$pu $X_0 = 0.1$pu
Transformer: $X_1 = X_2 = X_0 = 0.12$pu
Line: $X_1 = X_2 = 0.25$pu $X_0 = 0.75$pu
Equivalent system: $X_1 = X_2 = X_0 = 0.15$pu. Draw the sequence network diagrams for the system and indicate all per unit values. **(04 Marks)**

Module-4

7 a. Define faults. Classify the unsymmetrical faults with its frequency of occurrence. **(04 Marks)**

b. Derive expression for fault currents if double line to ground fault occurs through fault impedance Z_f on a power system. **(08 Marks)**

c. A three phase generator with an open circuit voltage of 400V is subjected to an LG fault through a fault impedance of j2Ω. Determine the fault current if $z_1 = j4\Omega$, $z_2 = j2\Omega$ and $z_0 = j1\Omega$. Repeat the problem for LL fault. **(04 Marks)**

OR

8 A synchronous motor is receiving 10MW of power at 0.8pf lag at 6KV. An LG fault takes place at the mid point of the transmission line as shown in Fig.Q.8. Find the fault current. The ratings of the generator, motor and transformer are as follows.
Generator: 20MVA, 11KV, $X_1 = 0.2$pu, $X_2 = 0.1$pu, $X_0 = 0.1$pu
Transformer T_1: 18MVA, 11.5Y-34.5KV, X = 0.1pu
Transmission line: $X_1 = X_2 = 5\Omega$ $X_0 = 10\Omega$
Transformer T_2: 15MVA 6.9Y – 34.5Y KV X = 0.1pu
Motor: 15MVA, 6.9KV, $X_1 = 0.2$pu, $X_2 = X_0 = 0.1$pu.

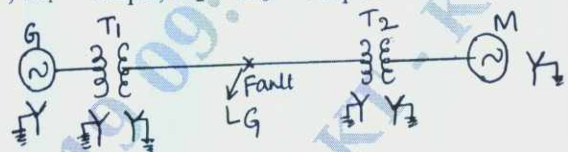


Fig.Q.8

Draw all the sequence network. **(16 Marks)**

Module-5

9 a. Derive the power angle equation of a non-salient pole synchronous machine. **(08 Marks)**

b. Find the steady state stability limit of a system consisting of a generator of equivalent reactance 0.5pu connected to an infinite bus through a series reactance of 1pu. The terminal voltage of the generator is held at 1.2pu and voltage of the infinite bus is 1.0pu. **(04 Marks)**

c. Define: i) Steady state stability and ii) Transient state stability. **(04 Marks)**

OR

10 a. Write short notes on: i) Equal area criterion ii) Swing curve **(08 Marks)**

b. A loss free alternator supplies 50MW to an infinite bus, the steady state stability limit being 100MW. Determine if the alternator will remain stable if the input to the prime mover of the alternator is abruptly increased by 40MW. **(08 Marks)**

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CBCS SCHEME

USN | | | | | | | | | | |　　　**15EE63**

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Digital Signal Processing

Time: 3 hrs.　　　Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Find 4 point DFT of $x(n) = \{1, -2, 3, 4\}$ and plot magnitude and phase response. **(06 Marks)**

b. If $x_1(n) = \{2, 3, 1, 1\}$ and $x_2(n) = \{1, 3, 5, 3\}$, find $x_3(n) = x_1(n)$ ④ $x_2(n)$ use matrix method **(06 Marks)**

c. Prove the time reversal property of DFT. **(04 Marks)**

OR

2 a. Perform circular convolution of $x_1(n) = \{2, 1, 2, 1\}$ and $x_2(n) = \{1, 2, 3, 4\}$ using circular shift method. **(05 Marks)**

b. Find linear convolution using DFT for the given sequence $x(n) = \{1, 2, 3\}$ $h(n) = \{1, 2, 2, 1\}$. **(06 Marks)**

c. Find the IDFT of the given sequence $x(k) = \{3, 2+j, 1, 2-j\}$. **(05 Marks)**

Module-2

3 a. Find the 8-point DFT of sequence $x(n) = \{1, 1, 1, 1, 0, 0, 0, 0\}$ using DIT FFT radix 2 algorithm. Draw signal graph. **(08 Marks)**

b. Develop a Decimation in Frequency FFT algorithm for N = 8. Draw signal flow graph. **(08 Marks)**

OR

4 a. Develop a decimation in time algorithm FFT of N = 8 draw signal flow graph. **(08 Marks)**

b. Calculate 8-point DFT of sequence $x(n) = \{1, -1, -1, -1, 1, 1, 1, -1\}$, using DIF – FFT radix -2 algorithm. **(08 Marks)**

Module-3

5 a. Design an analog Chebyshev with following specification.
Passband : 1db for $0 \le \Omega \le 10$ rad/sec
Stopband attenuation : -60 db for $\Omega \ge 50$ rad/sec. **(10 Marks)**

b. The system function of an analog filter is given as $H_a(s) = \dfrac{1}{(s+1)(s+2)}$. Obtain H(z) using impulse invariant method take sampling frequency as 5 samples/sec. **(06 Marks)**

OR

6 a. Design a low pass Butterworth filter using bilinear transformation method to meet the following specification take T = 2sec
Passband ripple ≤ 1.25dB
Passband edge = 200 Hz
Stopband attenuation ≥ 15dB
Stopband edge = 400Hz
Sampling frequency = 2KHz **(10 Marks)**

b. Prove the following transformation relation for impulse invariant transform.

$$\frac{s+a}{(s+a)^2+b^2} = \frac{1-e^{aT}(\text{Cos}\, bT)z^{-1}}{1-2e^{-aT}(\text{Cos}\, bT)z^{-1}+e^{-2aT}z^{-2}}$$ **(06 Marks)**

Module-4

7 a. Compare bilinear transformation with impulse invariance transformation. **(04 Marks)**

b. Write a note on frequency warping. **(06 Marks)**

c. Determine Direct form – I and II for 2^{nd} order filter given by
$y(n) = 2b \cos w_0\, y(n-1) - b^2 y(n-2) + x(n) - b \cos w_0\, x(n-1)$ **(06 Marks)**

OR

8 a. Obtain the Cascade form realization for given system.

$$H(z) = \frac{(z-1)(z-2)(z+1)z}{\left(z-\frac{1}{2}-\frac{1}{2}j\right)\left(z-\frac{1}{2}+\frac{1}{2}j\right)\left(z-\frac{1}{4}j\right)\left(z+\frac{1}{4}j\right)}$$ **(08 Marks)**

b. Design a second order lowpass digital Butterworth filter with cutoff frequency 1KHz and sampling frequency of 10^4 samples/sec by linear transformation. **(08 Marks)**

Module-5

9 a. Given the FIR filter with following deference equation
$y(n) = x(n) + \frac{2 \cdot x}{5}(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3)$. Draw direct Form – I and lattice structure. **(08 Marks)**

b. Using frequency sampling method, design a band pass filter with following specification determine the filter coefficient for N = 7, sampling frequency F = 8000Hz, cutoff frequency $f_{c_1} = 1000\text{Hz}$, $f_{c_2} = 3000\text{Hz}$ **(08 Marks)**

OR

10 a. Realise the following system function in cascade form
$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{3}{4}z^{-3} + z^{-4}$ in direct form I and cascade form. **(08 Marks)**

b. Design the symmetric FIR lowpass filter whose desired frequency response is given as

$$H_d(\omega) = \begin{cases} e^{-j\omega z}, & \text{for } |\omega| \le \omega_c \\ 0, & \text{otherwise} \end{cases}$$

The length of filter should be 7 and $\omega_c = 1$ rad/sample use rectangular window. **(08 Marks)**

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CBCS SCHEME

USN | | | | | | | | | | 15EE64

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Electrical Machine Design

Time: 3 hrs. Max. Marks: 80

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Assume any missing data suitably.*

Module-1

1 a. What are limitations involved in design of electrical machines? **(06 Marks)**
b. What are the desirable properties of conducting materials? **(05 Marks)**
c. What are ferromagnetic materials and solid core materials? **(05 Marks)**

OR

2 a. Compare aluminium and copper wires. **(04 Marks)**
b. What are the desirable properties of insulating materials? Give the classification of insulating materials based on thermal consideration with two examples in each class. **(08 Marks)**
c. What is cold rolled grain oriented silicon steel? What are advantages of using these materials in electrical machines? **(04 Marks)**

Module-2

3 a. Define "specific magnetic loading" and "specific electric loading". What are advantages and disadvantages of using higher specific loadings? **(08 Marks)**
b. Find the main dimensions and number of poles of a 50HP, 230V, 1400rpm shunt motor so that a square pole is obtained. Specific magnetic loading in the air gap is 0.5 weber/m^2 and the ampere conductors per are 22,000. The ratios of pole arc to pole pitch is 0.7. Assume the efficiency as 90%. Check that the obtained values are within permissible limits. Take 1 HP = 0.7355KW. **(08 Marks)**

OR

4 a. What are the advantages and disadvantages of large number of poles in d.c. machines? **(06 Marks)**
b. Calculate the diameter and length of armature for a 7.5kW, 4 pole, 1000rpm, 220V shunt motor. Given that the full load efficiency is 83%. Maximum air gap flux density is 0.9 webers/m^2. Specific electric loading is 30,000 ampere conductors per meter, field form factor is 0.7. Assume that the maximum efficiency occures at full load and field current is 2.5% of rated current. The pole face square. **(10 Marks)**

Module-3

5 a. Prove that EMF /turn of a single phase transformer is $K\sqrt{Q}$ where Q = output KVA rating of transformer per phase. **(06 Marks)**
b. The tank of a 1250 KVA natural oil cooled transformer has the following dimensions, length width and height as 0.65m, 1.55m and 1.85m respectively. The full load loss is 13.1 kW. Assume heat dissipation due to convection as 6.5W/m^2 °C and due to radiation as 6.0W/m^2 °C. Improvement in convection due to provision of tubes is 40%. Limit for temperature rise is 40°C. Length of each tube is 1.0m and diameter of each tube is 50mm. Find number of tube to be provided for the transformer. Neglect top and bottom surfaces of the tank as regards cooling. **(10 Marks)**

OR

6 a. Derive the output equation of a three phase core type of transformer. **(06 Marks)**

b. Determine the dimensions of core, the number of turns, the cross section area of conductors of primary and secondary windings of a 100KVA, 2200V/480V single phase core type of transformer to operate at a frequency of 50Hz by assuming the following data :
Approximate volts per turn = 7.5V, maximum flux density is 1.2 weber/m^2. Ratio of effective cross section area of core to the square of the diameter of circumscribing circle is 0.6, Ratio of height to width of window is 2.0, window space factor K_w = 0.28, current density δ = 2.5A/mm^2. **(10 Marks)**

Module-4

7 a. Derive the output equation of a three phase induction motor. **(06 Marks)**

b. Determine the main dimensions, turns per phase number of slots, conductor cross section and slot area of a 250HP, 3 phase, 50HZ, 400V, 1410 rpm, slip ring induction motor. Assume specific magnetic loading, B_{av} = 0.5T, specific electric loading, ac = 30,000 ampere conductors per meter, efficiency is 90%, winding factor is 0.955, current density = 3.5 A/mm^2. The slot space factor is 0.4 and ratio of core length to pole pitch is 1.2. The machine is delta connected. Take 1 HP =0.7355 kW. **(10 Marks)**

OR

8 a. What are the factors to be considered for estimating the length of air gap for induction motors? Explain them. **(06 Marks)**

b. Estimate the stator dimensions, number of stator slots, and number of stator conductor per slot for a 100kW, 3300V, 50Hz, 12 pole, star connected slip ring induction motor. Assume an average flux density of 0.4 webers/m^2 in the air gap, ampere conductors per meter as 25,000, efficiency is 90%, power factor = 0.9 and winding factor = 0.96. Choose main dimensions to give best power factor. The slot loading must not exceed 500 ampere conductors. **(10 Marks)**

Module-5

9 a. Derive the output equation of a synchronous machine in terms of its main dimensions and specific loadings. **(06 Marks)**

b. Find the main dimensions of a 100MVA, 11KV, 50Hz, 150rpm, 3 - phase, water wheel driven alternator. The average air gap flux density is 0.65 webers/m^2 and ampere conductors per meter are 40,000. The peripheral speed should not exceed 65m/sec at normal running speed in order to limit the runaway speed. Assume a winding factor K_{ws} = 0.955. **(10 Marks)**

OR

10 a. Define Short Circuit Ratio (SCR) of a synchronous machine and discuss its effects on the
b. machine performance. **(08 Marks)**

c. Determine the main dimensions of a 1000KVA, 50Hz, 3-phase, 375 rpm alternator. The average air gap flux density is 0.55 webers/m^2 and the ampere conductors per meter are 28,000. Use rectangular poles and assume a winding factor K_{ws} = 0.955. Bolted on pole construction is used for which the maximum permissible peripheral speed is 50 meters/sec. The runaway speed is 1.8 times the synchronous speed. **(08 Marks)**

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