(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 3988 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. IV) THEORY EXAMINATION 2011-12

ELECTRICAL MACHINES AND AUTOMATIC CONTROL

Time : 3 Hours *Total Marks : 100*

Note :—Attempt **all** questions.

1. Answer any **two** parts :— (10×2=20)

   (a) What is voltage regulation ? What are its importance ? Develop an expression for calculating the voltage regulation of a two winding transformer under lagging power factor condition.

   (b) A 10 kVA, 200/400 V, 50 Hz, single phase transformer gave the following test resutls :

   Open circuit test (high voltage winding open) 200 V, 1·3 A, 120 W

   Short circuit test (low voltage winding short circuited) 22 V, 30 A, 200 W.

Calculate :—

(i) Magnetising current and current corresponding to core loss at normal voltage and frequency, and

(ii) parameters of equivalent circuit as referred to low voltage winding.

(c) Why is starter necessary for starting a dc motor ? Explain the working of a 3-point starter.

2. Answer any **two** parts :— **(10×2=20)**

(a) Derive the equation for the torque developed by a 3-ϕ induction motor. Draw a typical torque-slip curve and deduce the condition for maximum torque.

(b) A 3-phase, star connected alternator is rated at 1600 kVA, 13500 V. The armature resistance and synchronous reactance are 1·5 Ω and 30 Ω respectively per phase. Calculate the percentage regulation for a load of 1280 kW at power factors of

(i) 0·8 leading,

(ii) unity and

(iii) 0·8 lagging.

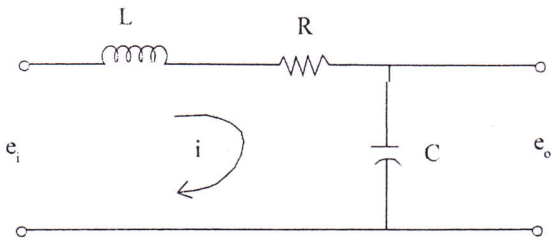
(c) Why is it so that a synchronous motor develops torque only at synchronous speed whereas an induction motor develops torque at all speeds except synchronous speed ?

Describe briefly the effect of varying excitation upon armature current and power factor of synchronous motor when the input power to the motor is maintained constant.

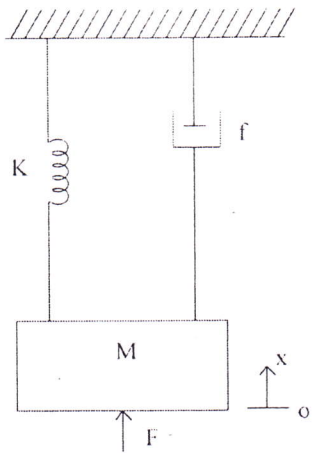
3. Answer any **four** parts :— **(5×4=20)**

(a) Distinguish between open loop and closed loop control systems.

(b) Derive the transfer function of the network shown below :



(c) Explain force-voltage analogy of translational mechanical system. Draw the analogous electrical system.



(d) Write the differential equation of translational system shown below. Also draw the free-body diagram of the system.

(e) Write a short note on servomotor.

(f) Consider the following sinusoidal function

$$f(t) = 0 \qquad \text{for } t < 0$$

$$= A \sin wt \quad \text{for } t \geq 0$$

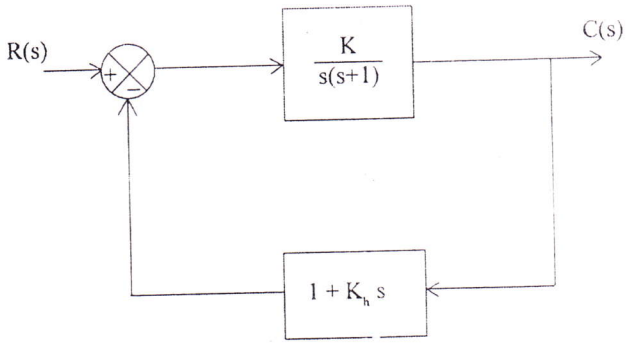
where A and w are constrants. Obtain the Laplace transform.

4. Answer any **two** parts :— (10×2=20)

(a) A unity feedback control system $G(s) = \frac{K(s+1)(s+2)}{(s+0{\cdot}1)(s-1)}$ has an open loop transfer function consisting of two poles, two zeros and a variable gain K. The zeros are located at –2 and –1; and poles at –0·1 and +1.

Using Routh stability criterion, determine the range of values of K for which the closed loop system has 0, 1 or 2 poles in the right-half s-plane.

(b) For the system shown below, determine the values of gain K and velocity feedback constant K_h so that the maximum overshoot is 0·2 and the peak time is 1 sec. With the obtained values of K and K_h, obtain the rise time and settling time.



(c) Sketch the polar plot of the transfer function given below. Determine whether the plot crosses the real axis. If so, determine the frequency at which the plot crosses the real axis and the corresponding magnitude | G(jw) |.

$$G(s) = \frac{1}{s(1+s)(1+2s)}.$$

5. Answer any **two** parts :— (10×2=20)

(a) A unity feedback system has an open-loop transfer function $G(s) = \frac{K}{s(s^2+4s+13)}$.

Sketch the root locus plot of the system determining the following :—

(i) Centroid, number and angle of asymptotes.

(ii) Angle of departure of root loci from the poles.

(iii) Breakaway point if any.

(iv) The value of K and the frequency at which the root loci cross the jw-axis.

(b) Draw the Bode plot for the transfer function

$$G(s) = \frac{75(1+0{\cdot}2s)}{s(s^2+16s+100)}.$$

From the plot, determine :

(i) gain cross-over frequency.

(ii) phase cross-over frequency.

(iii) gain margin and phase margin and

(iv) stability of the system.

(c) Write short notes on P, I and PI controllers.