Total No. of Printed Pages-7 Roll No. _____

1(CCE-M)6

ELECTRICAL ENGINEERING - II

[09]

Time Allowed -3 Hours *Maximum Marks-300*

INSTRUCTIONS

i) Answers must be written in English.

ii) The number of marks carried by each question is indicated at the end of the question.

iii) The answer to each question or part there of should begin on a fresh page.

iv) Your answer should be precise and coherent.

v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

*vi) Candidates should attempt Questions No. **1** is **compulsory**. Attempt **One** more questions from section A and Three more questions from section B or section C.*

vii) If you encounter any typographical error, please read it as it appears in the text book.

viii) Candidates are in their own interest advised to go through the General instruction on the back side of the title page of the answer script for strict adherence

ix) No continuation sheets shall be provided to any candidate under any circumstances.

x) Candidates shall put a cross (X) on blank pages of answer script

xi) No blank page be left in between answer to various questions.

xii) No programmable Calculator is allowed.

xiii) No stencil (with different markings) is allowed.

xiv) In no circumstances help of scribe will be allowed.

Section - A

1. Answer any **THREE**.

a) Construct the signal flow graph for the systems described by the following set of equations. Also find the transfer function using the Mason's gain formula.

i) $X_2 = X_1 - H_3X_4, X_3 = G_1X_2 - H_2X_5, X_4 = G_2X_3, X_5 = G_3X_4 + H_1X_6$

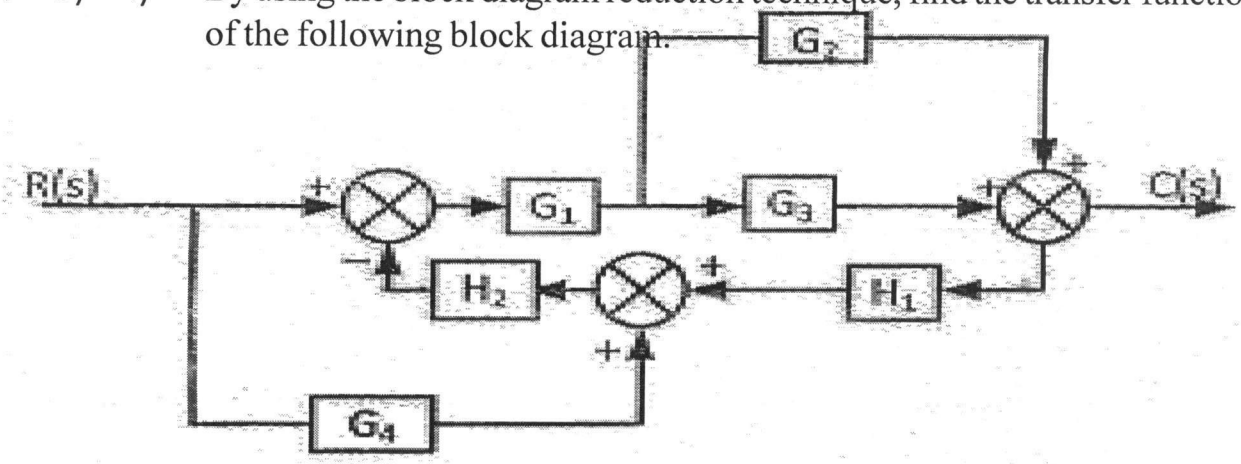
$X_6 = G_4X_5 + G_5X_3$ where X_1 is the input variable and X_6 the output variable.

ii) $X_2 = X_1 - H_1X_3 - H_2X_5, X_3 = G_1X_2, X_4 = G_2X_3 - H_5X_5,$

$X_5 = G_3X_4 - H_4X_6, X_6 = G_4X_5 - H_5X_7, X_7 = G_5X_6$, where X_1 is the input

variable and X_7 the output variable. **(20)**

b) i) By using the block diagram reduction technique, find the transfer function of the following block diagram.



(10)

ii) Find out the stability of the system having characteristic equation:

$s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$, by using Routh's Stability criterion. **(10)**

c) A signal phase full converter is connected to an AC supply of 240 sin 314t volts. It operates at a firing angle, $\alpha = \frac{\pi}{6}$. The load current is maintained constant at 5A and the load voltage is 120 V. Calculate:

i) the source impedance,

ii) Angle of overlap and

iii) load resistance. **(20)**

d) An armature circuit (RLE load) of a separately excited dc motor is fed from a three phase, six pulse, fully controlled converter. The supply ac voltage(line)=166 V, $R_a = 1.0\,\Omega$, $I_{rated} = 25$ A, Va (rated) = 220V. For the rated load current find the output voltage and the switching angle at

i) E=158 V and

ii) E=106 V. **(20)**

2. a) A load commutated chopper fed from a 220 V dc source has a constant load current of 40A. For a blocking period of 0.3 ms and a chopping frequency of 2 KHz, calculate

i) the value of commutating capacitance

ii) average output voltage

iii) circuit turn - off time and

iv) total commutation interval. **(20)**

b) The square wave output voltage of a bridge inverter has a magnitude of 120 V and frequency of 50 Hz. The inverter is supplying an RC load with $R = 15\Omega, C = 2.75\mu F$. Draw the waveforms of capacitor voltage and capacitor current:

i) for the first cycle and

ii) under steady - state condition. **(20)**

c) State Nyquist stability criteria and investigate the stability of closed loop system with the open loop transfer function $G(s)H(s) = \frac{z(s+3)}{s(s-1)}$ by drawing Nyquist plot. **(20)**

3. a) A second order servo system has poles at - $2 \pm j3$ and zero at 2. Its steady state output for a unit step input is 5. Determine the transfer function. What is its peak overshoot for a unit step input? **(20)**

b) Draw the root locus for a unity feedback system with open - loop transfer function given by $G(s) = \frac{k}{(s+3)(s+5)(s^2+2s+2).}$ **(20)**

c) The single phase ac voltage regulator has 140 Volt (rms), 50 Hz source. The load resistance is 15Ω. Determine the i) delay angle required to deliver 550 W to load, ii) rms source current, iii) input power factor and iv) THD of the source current. **(20)**

Section - B

4. a) A 3- phase, 50 Hz transmission line has resistance inductance and capacitance per phase of 8Ω $0.15H$ *and* $0.8\ \mu F$. respectively, and delivers at a load of 40 MW at 132 kv and 0.8 p.f. lagging. Determine the efficiency and voltage regulation of line using nominal - T method. **(20)**

b) A constant load of 400 MW is supplied by two 250 MW generators, 1 and 2 for which the respective incremental fuel costs are

$$\frac{dF_1}{dp_1} = 0.12\ P_1 + 20Rs / MWh,$$

$\frac{dF_2}{dp_2} = 0.10\,P_2 + 15\ \ Rs/MWh,$ with Powers P in MW and costs F in Rs/hr.

Determine

i) the most economical division of load between the generators, and

ii) the saving in Rs/day thereby obtained compared to equal load shoving between the generators. **(20)**

c) Draw neat phasor diagram and Torque - Speed characteristics of single phase capacitor - start motor and Capacitor - start capacitor - run motors. Compare their performance on the basis of these characteristics. **(20)**

5. a) A 25 MVA, 33kv, 3 - phase alternator is subjected to different types of short circuits and the following are the values of fault current :

3 - phase short circuit current - 325 A

Single line - to - ground fault current - 668 A

Line - to - line fault current - 445 A

Determine the positive, negative and zero sequence reactances of the generator in per unit and in ohms. Neglect resistive part. **(20)**

b) A 3- phase induction motor has a starting torque of 100% and a maximum torque of 200% of the full - load torque. Find slip at maximum torque. **(20)**

c) Define string efficiency with respect to a suspension insulator assembly. Determine voltage across each units of a suspension insulator (total three units) as a percentage of the line voltage to each disc voltage. The self - capacitance and capacitance to ground of each disc is C & 0.2 C respectively. The capacitance between the link pin and the guard ring is 0.3C. Also find string efficiency. **(20)**

6. a) What is meant by 3 - zone protection scheme? Give such scheme of protection for EHV transmission line. **(20)**

b) A 50 Hz two pole turbo alternator rated 50 MVA, 13.2 kv has an inertia constant H= 5.5 MJ/MVA. Determine the kinetic energy stored in the rotor at synchronous speed. Determine the acceleration if input rotational losses is 6500 HP and the electrical power losses is 50 MW. If the acceleration com-

puted for the generator is constant for a period of 10 cycles, determine the change in torque angle in that period and the r.p.m at the end of 10 cycles. Assume that the generator is synchronized with a large system & has no accelerating torque before the 10 cycles period begins. **(20)**

c) Calculate the r.m.s value of the induced emf per phase of a 10 pole, 3 -phase, 50 Hz alternator with 2 slots per pole per phase and 4 conductors per slot in two layers. The coil span is 150^{o}. The flux per pole is 0.15 weber. **(20)**

7. a) A circuit breaker is rated as 2500 A,1500 MVA, 33kv, 3 seconds, 3 -phase oil circuit breaker. Determine the rated symmetrical breaking current, rated making current, short time rating and rated service voltage. **(20)**

b) A three phase, 30 HP, 230 V, 50 Hz, induction motor draws 66 A from the source at 0.85 lagging power factor. The motor has:

Stator copper loss - 900 W,

Magnetic core loss - 500 W,

Rotor copper loss - 1100 W

and rotational loss - 500 W.

Determine :

i) the air gap power

ii) slip

iii) Mechanical power developed,

iv) output power and

v) efficiency of the motor. **(20)**

c) Illustrate the working, operating characteristics and applications of Amplidyne. **(20)**

Section - C

8. a) Obtain expression for the field and power radiated by half wave antenna, and calculate the radiation resistance of antenna. **(20)**

b) A plane wave propagates in free- space with a peak electric filed of E = 20 V/m. Find:

i) the peak Poynting vector.

ii) the average Poynting vector,

iii) and the peak value of magnetic field H. **(20)**

c) Calculate the noise voltage at the input of a television RF amplifier using a device that has 210 Ω equivalent noise resistance and a 300 Ω input resistance. The bandwidth of the amplifier is 6MHz and the temperature is 20°C. **(20)**

9. a) An antenna has an effective length of 110 metres and the current at the base is 500 amperes (rms) at 40 kHz. What is the power radiated? If the total resistance of the antenna circuit is 1.15 Ω., what is the efficiency of the antenna? **(20)**

b) In a commercial broadcasting system the FM signal has a centre frequency of 105 MHz, and the highest frequency of 105.04 MHz, when modulated by a signal of frequency 5 kHz, determine

i) Frequency deviation,

ii) Carrier swing,

iii) Modulating Index, and

iv) Percentage Modulation. **(20)**

c) Sketch the circuit of direct coupled amplifiers. Derive expression for V_o. Also Explain the principle of operation. **(20)**

10. a) What is the capture area of an antenna whose directive gain at 20 GHz is 20 dB? **(20)**

b) What is multiplexing? Why it is needed? Also describe its different basic forms? **(20)**

c) In the ionospheric propagation, consider that the reflected takes place of a height of 350 km and that maximum density in the ionosphere corresponds to a refraction index of 0.9 at a frequency of 16 GHz. Determine the ground range for which this frequency is MUF (Maximum Usable Frequency). Take the earth's curvature into consideration. **(20)**

11. a) Define noise figure and the signal to noise ratio (SNR). If each stage of a two stage cascade amplifier has a gain of 15 dB and noise figure of 15 dB, calculate the total noise figure in dB. **(20)**

b) A 30 MHz carrier is modulated by a 700 Hz audio sine wave. If the carrier voltage is 5V and the maximum deviation is 14 kHz, write the equations of this modulated wave for FM and PM. If the modulating frequency is now changed to 2.0 kHz, all others remaining unaltered, write the new equations for FM and PM. **(20)**

c) From the expression for instantaneous voltage of an AM wave, derive a formula for r.m.s. value of this wave. **(20)**
