CMD

2006

ELECTRICAL ENGINEERING - I (Optional)

Standard : Degree *Total Marks : 200*

Nature : Conventional *Duration : 3 Hours*

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Note :

(i) *Answers must be written in* ***English.***

(ii) *Question* ***No. 1*** *is* ***Compulsory.*** *Of the remaining questions, attempt* ***any four*** *selecting one question from* ***each section.***

(iii) *Figures to the* ***RIGHT*** *indicate marks of the respective question.*

(iv) *Make suitable assumptions, wherever be necessary and state the same.*

(v) *Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.*

(vi) *Credit will be given for orderly, concise and effective writing.*

(vii) *Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he will be penalised.*

1. ***Answer any four of the following :***

(a) An electric lift makes 12 double journeys per hour. A load of 5×10^3 kg is raised by it through height of 50 m, and it returns empty. The lift takes 65 sec to go up and 48 sec to return. The mass of empty cage is 500 kg and counter weight 2500 kg. The efficiency of system is 68%. Find energy consumption, for one hour in kwh. **10**

(b) Explain with neat circuit diagram, how a d'Arsonval basic meter movement is converted into a multirange voltmeter (three - ranges) on the basis of potential divider arrangement. Also derive the formula for necessary resistance for range-extension. **10**

(c) Input to a single phase short transmission line is 2000 kW at 0.8 lagging power factor. The line has series impedance of $(0.4 + j\,0.4)$ ohm. The load side voltage is 3 kV. Find the load and receiving end power factor. Also find supply voltage. **10**

(d) Design astable multivibrator using IC 555, which will give output 5 kHz and duty cycle 75% square wave. **10**
Draw the circuit diagram for the above operation.

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(e) In connection with distribution transformer define 10
(i) All day efficiency
(ii) Voltage regulation.
Also explain in detail procedure for calculating efficiency and regulation by indirect test.

SECTION - A

2. *Answer the following sub-questions :*

(a) A series connected 20 ohm resistor and inductance 0.1 henry are supplied by voltage $V_{(t)} = 100\cos\left(10^3 t + \frac{\pi}{2}\right)$ through a switch. Obtain solution for current when switch is closed at $t = 0$. 10

(b) With usual notations obtain Maxwell's equation for static electric field. 10

(c) (i) Draw Torque - Speed and Torque - Current characteristics for *dc* shunt, *dc* series and *dc* compound motors. 5

(ii) A 3 phase, 50 Hz, 50 kW induction motor has an efficiency of 90% at rated output. At this load the stator copper loss and rotor copper loss are equal to stator core loss. The friction and windage loss is equal to one third of stator core loss. 15
Calculate :
(i) Rotor copper loss
(ii) Air gap power
(iii) Slip
(iv) Mechanical power output at shaft.

3. *Answer the following sub-questions :*

(a) In context for solving a electric network what is the significance of initial conditions. Elaborate answer with suitable examples. 10

(b) Potential is given by $V = 2\ (x+1)^2\ (y+2)^2\ (z+3)^2$ V in free space. At a point P (2, −1, 4). 10
Calculate :
(i) the potential at point P
(ii) electric field intensity
(iii) flux density D at point P
(iv) volume charge distribution at point P, and
(v) unit vector in potential gradient direction at P.

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(c) (i) Why synchronous motor are not self starting ? State the methods of starting synchronous motor. 5

(ii) A 250 V dc shunt motor has armature winding resistance of 0.6 ohm and of field winding 150 ohm. The motor operates on no load with full field flux with base speed 1000 rpm, with $I_a = 5A$. If machine drives a load requiring torque 100 Nm. Calculate armature current and speed of motor. If the motor is required to develop 10 kW at 1200 rpm, what is the required value of the external series resistance in the field circuit ? Neglect saturation and armature reaction. 15

SECTION - B

4. *Answer the following sub-questions :*

(a) (i) What is megger ? Where it is used ? Comment on it's scale. 5

(ii) A resistance strain gauge with a gauge factor of 6 is cemented to a steel bar member, which is subjected to a strain of 5×10^{-3}. If the original resistance value of the gauge is 200 ohm, calculate the change in resistance. 5

(b) Block diagram of the control system is shown in fig. 4 (b). Determine the closed loop transfer function C (S)/ R (S) using block diagram reduction technique. 10

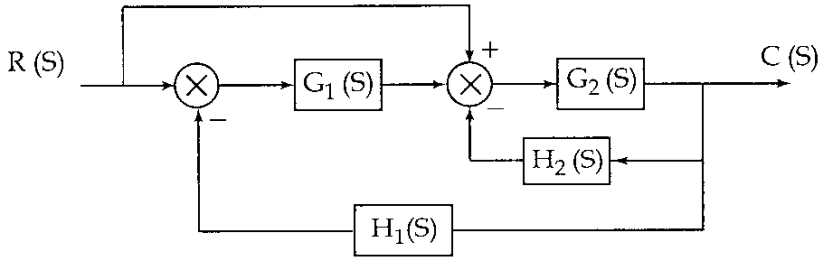

Fig. 4 (b)

(c) Unity feedback system is characterised by open loop transfer function $G(S) = \frac{K}{S(S+10)}$. Determine value of 'K' so that the system will have a damping ratio of 0.5. Assume input to the system to be step input. 10

(d) Discuss the effect of P, PI and PID controllers when introduced in a feedback control system to improve the performance and to achieve better control action. 10

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SECTION - D

8. *Answer the following sub-questions :*

(a) Draw the circuit diagram of full wave rectifier supplying a load through capacitor filter. (Assume transformer has centre tap). Also draw the waveforms at input of the transformer, output of the transformer, voltage across each diode, waveform at the output of the filter. **10**

(b) (i) Draw the single stage CE BJT amplifier practical circuit. Name all the components used in it. Draw the frequency response for the above operation. Indicate on the graph cutoff frequency, band-width etc. on it and explain. **10**

(ii) Draw the circuit of *op-amp* as a inverting summing amplifier and write expression for the output voltage in terms of inputs and input-feedback resistors. **5**

(c) (i) Prove the following using Boolean algebra : **5**

$$ABC + A\bar{B}C + \bar{A}BC + AB\bar{C} + A\bar{B}C + \bar{A}\bar{B}C = AB + C$$

(ii) What is multiplexer ? Draw 8 : 1 multiplexer. Design 8 : 1 multiplexer by two 4×1 multiplexers. **10**

9. *Answer the following sub-questions :*

(a) Explain with diagram how RC phase shift *op-amp* oscillator works. Determine the output frequency if this oscillator has three 2 kilo ohm resistances and three 0.1 microfarad capacitors in phase shift feedback network. **10**

(b) (i) State clearly the difference between BJT and FET components on the basis of construction, operation and input-output resistances. Also draw the circuit diagram FET working as a amplifier with it's drain characteristics and transfer characteristic. **10**

(Assume common source N-channel FET for analysis).

(ii) What is filter ? Draw the diagram of *op-amp* as low-pass filter with its characteristic. **5**

(c) (i) Draw the logic gate diagram and truth table of half adder and half subtractor combinational circuits. **10**

(ii) List the various logic families used in digital IC fabrication. Also define the term fan-out used in connection with the digital IC characteristic. **5**

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5. *Answer the following sub-questions :*

(a) (i) Only draw generalised data acquision system block diagram schematic to understand the various parts of it. **5**

(ii) What is Q meter ? Only state the various methods for unknown components testing alongwith Q meter. **5**

(b) State what do you mean by positive feedback and negative feedback. What are their effects on the performance of the system. **10**

(c) Open loop transfer function of a unity feedback system is given by $G(S)H(S)=\frac{K(S+1.5)}{S(S+1)(S+5)}$. Draw the complete root locus. **10**

(d) Obtain state variable representation of the system describe by transfer function in phase variable form $\frac{C(S)}{R(S)}=\frac{10}{S^3+6S^2+11S+18}$. **10**

SECTION - C

6. *Answer the following sub-questions :*

(a) Develop sequence network diagram for single line to ground fault occurred at the terminals of synchronous generator. State necessary mathematical steps. **10**

(b) A 50 Hz, 11 kV generator is connected to a power system. The system inductance and capacitance per phase are 10 mH and 0.02 μF respectively. Calculate : **15**

(i) the maximum voltage across the contacts of circuit breaker at an instant when it passes through zero.

(ii) frequency of transient oscillation.

(iii) average rate of rise of voltage upto the first peak of oscillation. Neglect resistance.

Also state methods of arc extinction.

(c) (i) State different types of DC links and explain them in brief. Also state technoeconomic aspects of HVDC over HVAC systems. **10**

(ii) A 250 MVA synchronous generator operates on full load at a frequency of 50 Hz. The load is suddenly reduced to 125 MW. The governor has a dead band equivalent to 0.4 sec. Determine the change in frequency that occurs in this time. Given H = 5 kW - sec/kVA of generator. **5**

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7. *Answer the following sub-questions :*

(a) Fig. 7 (a) shows a station operating at 33 kV is consisting of 2 sections A and B. Section A consists of three generators, rating of each generator 15 MVA and reactance of 15%. Section B is fed from power grid through 75 MVA transformer with 8% reactance. The circuit breakers used each have rupturing capacity of 750 MVA. Determine the reactance of reactor to prevent the breakers being overloaded if a symmetrical short circuit occurs on an outgoing feeder connected to section A. **10**

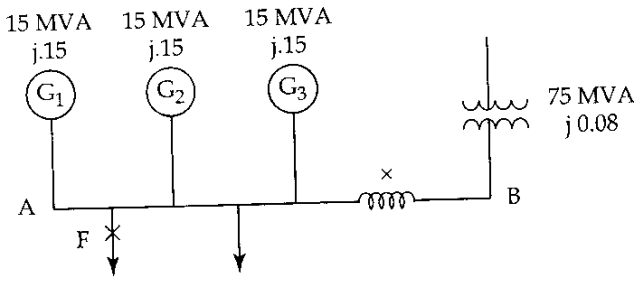

Fig. 7 (a)

(b) With help of neat diagram explain differential and restricted earth fault protection of a Star-Delta transformer. Also explain typical stepped distance protection for transmission line. **15**

(c) (i) Define FACTS controllers. Also draw schematic of UPFC. **5**

(ii) Fig. 7 (c) shows a two bus system. If 100 MW is to be delivered to load from generator 1, a transmission loss of 10 MW is taking place. Find out generation at two generating stations for above condition. Also calculate power received by load when the system λ is Rs. 25/MWh. **10**

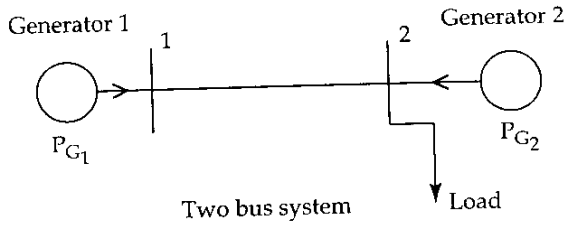

Fig. 7 (c)

The incremental fuel costs of two generator are

$$\frac{dC_1}{dP_{G_1}} = 0.02\,P_{G_1} + 16.0\ \text{Rs/MWh}$$

$$\frac{dC_2}{dP_{G_2}} = 0.04\,P_{G_2} + 20.0\ \text{Rs/MWh}$$

P.T.O.