Time: 3 Hours **Total Marks: 80**

N.B. 1) Question No. 1 is compulsory
2) Attempt any three from the remaining Questions No. 2 to No. 6.
3) Illustrate answers with diagrams wherever necessary.
4) Assumption made should be clearly stated.

Q 1. **Solve any four**

a) Why is a rotating field system used in preference to a stationary field? **05**

b) Explain the term unsaturated synchronous reactance. **05**

c) Explain the condition for parallel operation of alternator. **05**

d) Explain the working principle of synchronous motor. **05**

e) Write note on: Steady state analysis of synchronous machine. **05**

Q 2. a) What is armature reaction? Explain the effect of armature reaction on the terminal voltage of alternator at unity, lagging and leading power factor. **10**

b) A 3- phase star connected alternator is rated at 1600 KVA, 13500 V. The armature effective resistance and synchronous reactance are 1.5 ohms and 30 Ohms respectively per phase. Calculate the percentage voltage regulation for a load of 1280 KW at a power factor of (a) 0.8 leading (b) 0.8 lagging. **10**

Q 3. a) Explain the effect of varying excitation on armature current and power factor in a synchronous motor. **10**

b) Two station generators A and B operates in parallel. Station capacity of A is 50 MW and that of B is 100 MW. Full-load speed regulation of both station is 4%. Calculate the load sharing if the connected load is 100 MW. No-load frequency is 50 Hz. **10**

Q 4. a) Draw equivalent circuit and phasor diagram of a cylindrical rotor synchronous motor. **10**

b) Explain the significance of synchronising power and derive the equation of synchronising power and synchronising torque. **10**

Q 5. a) Explain Blondel's two reaction theory. **10**

b) Explain the application of synchronous motor. Compare synchronous motor and induction motor. **10**

Q 6. Solve any two. **20**

a) Explain the functions of damper winding in a synchronous motor.

b) Explain the characteristics of infinite bus bar.

c) Derive the basic machine relation in dq0 Variables.

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Duration – 3 Hours **Total Marks- 80**

N.B.: - (1) Question No.**1** is compulsory.
(2) **Attempt** any **Three** questions out of the remaining **five** questions.
(3) Assume suitable data if necessary and justify the same.

Q 1. Answer **all questions**.

A) Explain the terms short circuit MVA and symmetrical fault. **05**

B) Describe the volt time curve as required for insulation coordination studies in power system with an example **05**

C) Discuss in brief the significance of tower footing resistance **05**

D) Describe the working principle of lightning arrester. Explain any arrester in detail. **05**

Q 2 a) Illustrate the short circuit of synchronous machine at no load condition. **10**

Q 2 b) Build the Z-bus for the 3 Bus network in which elements are connected as **10**

Bus 1-Bus 2: j0.2;

Bus 1-Bus 2: j0.4;

Bus 1-Bus3: j0.35

Bus 2-Bus 3: j0.25. (Assume Bus 3 as a reference bus)

Q 3 a) Explain and draw the zero sequence networks for following types of connections of a three phase transformer **10**

i) Delta-Delta

ii) Delta-Star(ungrounded)

iii) Delta-Star(Grounded)

iv) Star(Grounded)- Star(Grounded)

v) Star(ungrounded)- Star(ungrounded)

Q 3 b) Derive the equation for fault current and sequence network for single line to ground fault. State the various assumptions in derivation. **10**

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Q 4 a)	A star connected balanced load of 10ohm each has the following voltages across its terminals Vab=200V, Vbc=220V and Vca=180V.Calculate the symmetrical components of line and phase voltages. From the symmetrical components of line voltages determine the line current.	**10**
Q 4 b)	Describe the generation of voltage and current travelling waves on a short circuited line with figure and equations.	**10**
Q 5 a)	Explain the principle of lightning phenomenon and protection against lightning with respect to power system.	**10**
Q 5 b)	Discuss the advantages and disadvantages of Corona	**10**
Q 6 a)	Describe the Z-bus formulation.	**10**
Q 6 b)	Explain the following (i) critical disruptive voltage and visual disruptive voltage (ii) transient recovery voltage	**10**

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Time: 3 Hours **Total Marks: 80**

N.B: (1) Question No. 1 is compulsory.
(2) Attempt any three from the remaining questions.
(3) Figures to the right indicate full marks.
(4) Use Graph paper and semi log paper wherever necessary.

1. Attempt any four. 20
(A) Explain the effects of addition of open loop poles and zeros on root locus and transient response.
(B)Derive force to current analogy between mechanical and electrical system.
(C)Define the term damping ratio and explain its condition for stability.
(D Explain advantages of state space approach over conventional approach.
(E)Explain stability condition of Bode plot by using suitable diagram.

2. (A) Consider a unity feedback system with closed loop transfer function 10

$C(s)/R(s)=2/(s^2+3s+7)$. Find open loop transfer function. Show that the steady state error in the unit step response is 0.714.

(B) Determine the range of operating values of K so that system will be stable for the unity feedback system having characteristic equation as $S^4+5S^3+5S^2+4s+k = 0$ by Routh Hurwitz Method. 10

3. (A)) For the unity feedback system find the steady state error for the following test input of 2+6t for G(s)=1000(S+6)/(S+7)(S+10). 10

(B) The unity feedback system is characterized by an open loop transfer system G(s)= 10/(S+2)(s+5).Determine damping ratio, undamped natural frequency of oscillation. What is the percentage overshoot of the response to a unit step input. 10

4. (A)Determine gain margin, phase margin, gain crossover frequency and phase cross over frequency for following transfer function: 10

$$G(s) = \frac{100(s+4)}{s(s+0.5)(s+10)}$$

(B) Sketch the root locus for unity feedback system for the transfer function given below: 10

$$G(s) = \frac{20}{S(S+2)(S+4)}$$

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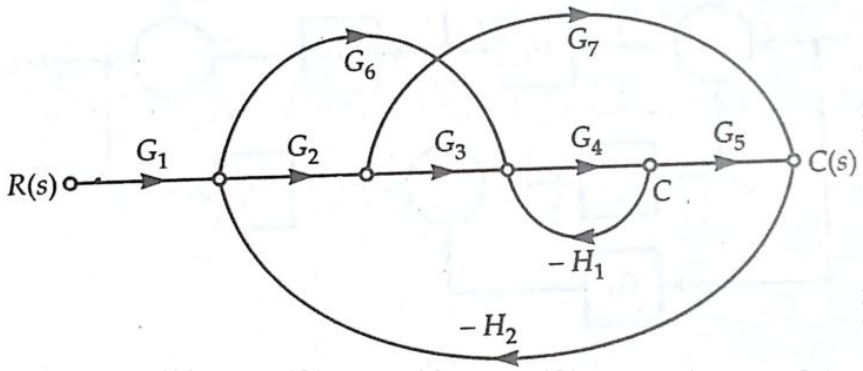
5. (A) Use Mason gain formula to find C(s)/R(s) of following signal flow graph: 10



(B) Represent the following system in state space in phase variable form and draw its state model. 10

$$G(s) = \frac{100(s+5)}{s(s+1)(s+4)}$$

6. Write notes on any two: 20

(A) Define Gain Margin, Phase Margin, Phase cross over frequency and gain Cross over Frequency in frequency domain
(B) Draw the block diagram of closed loop linear time invariant system and define its components.
(C) Write a short note on State Transition Matrix.

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Time: 3 Hours **Marks: 80**

Note:1 Question No.1 is compulsory.
2. Solve ANY THREE questions from the remaining five questions.
3. Figure to the right indicates full marks.
4. Assume suitable data wherever required, but justify the same.

Q. 1 Solve **ANY FOUR** questions from following. (Each question carries 5 marks)

a) Explain differential area in rectangular, cylindrical and spherical co-ordinate systems with an example. Give its significance **(05)**

b) Explain and derive the polarization of a dielectric material. **(05)**

c) What are advantages and limitation of Lorentz's force equation? **(05)**

d) 'The line integral of the magnetic field intensity around some closed loop is equal to the sum of the currents which pass through the loop.'Is the statement true or false. Justify the same. **(05)**

e) Point charge Q= -0.2 μC placed at origin in free space. Find electric field intensity and electric potential at (0,6,8)m. **(05)**

Q. 2 a) Formulate electromagnetic wave equation from Maxwell's equation for perfectly conducting and insulating media. **(10)**

Q. 2 b) State coulomb's law. Also derive electric field intensity due to an infinite and finite plane having density $\rho_s \left(C/m^2\right)$. **(10)**

Q. 3 a) If a current density is directed radially outward and decreases exponentially with time $\bar{J}=\frac{10}{r} e^{-t} \bar{a_r}$ A/m^2 Calculate current I at **(10)**
1) t=1 and r=5m ,
2) t=1 r=6 ,
And also calculate rate of change of volume charge density

Q. 3 b) Derive the expression for magnetic field intensity due to infinite and finite wire carrying current I. **(10)**

Q. 4 a) Derive electrostatic Gauss Divergence equation in both integral and point form. **(10)**

Q. 4 b) Give the potential difference $V=2x^2y-5z$ and a point p(-4,3,6)m. Find the electric field intensity and flux density at P.

Q. 5 a) Derive Kirchhoff current law KCL from continuity equation of current. **(10)**

Q. 5 b) Derive Faraday's law of electromagnetic induction in time and frequency. Domain. **(10)**

Q. 6 a) Use Biot-Savart's Law for any finite current carrying conductor to find magnetic field intensity. **(10)**

Q. 6 b) Find charge Q and volume charge density $\rho_v \left(C/m^3\right)$ for **(10)**
$\bar{D} = e^{-x} \sin y\, \bar{a_x} - e^{-x} \cos y\, \bar{a_y} + 2z\bar{a_z}$
For a cube with $-10 \le x \le 10$, $-10 \le y \le 10$, $-10 \le z \le 10$

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Time : 3 Hours **Marks : 80**

Instruction to candidates:

1. **Question No. 1 is compulsory**
2. **Answer any three out of the remaining questions**
3. **Assume additional data if needed**

1. Answer **ANY FOUR** questions from the following.

i What is the need for a Multi-level inverter? List three types of Multi-level inverters. [5]

ii Explain briefly the operating principle of a Buck dc-dc converter in Discontinuous Conduction Mode (DCM). Draw the inductor voltage and inductor current waveform. [5]

iii Briefly explain how resonant switch converters addresses the drawbacks when power electronics devices are used for high frequency applications. [5]

iv Which core material is preferred for making high frequency inductors and transformers. Justify. [5]

v State the advantages of Switched Mode Power Supply. [5]

2. A Derive the control to output transfer function of an ideal Buck dc-dc converter in continuous conduction mode. [20]

3. A With neat diagrams of the converters, compare and contrast Forward and Full Bridge dc-dc converters in power electronics. [10]

B A buck converter is working in just continuous mode feeding a resistive load. If ΔI_L is 1.5 A, D=0.4, frequency=20kHz, average output voltage is 30 V, (i)find the supply voltage;(ii) average inductor current;(ii) inductance required. Assume that all the components are ideal, and the duty ratio and switching frequency remain same. [10]

4. A With neat diagrams describe the operation of Zero Current Switched resonant switch converter. [10]

B In a flyback converter, Input Voltage=300V, Vout=5V, D=0.4, I_{out}=30A, f_{sw}=40kHz.Calculate the following: i) Turns ratio (N_1/N_2), ii) Input current iii) magnetizing current, iv) Prove that magnetizing inductance (Lm) is 1.2mH. Assume negligible ideal components and the current is just continuous/boundary. [10]

5. A Select a core and wire size for a high frequency inductor for an Buck dc-dc converter in Continuous Conduction Mode with the parameters given. V_o= 5V, output current= 5A, f_s= 40kHz, supply voltage, V_d =12V±10%; Δi_L =10% of average inductor current, B_m=0.2T, K_w=0.6, K_c=1, J=3A/mm^2. Refer Appendix for core size and wire size. [10]

B Compare current control and voltage control of dc-dc converters. [10]

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6. A Explain any residential application of a Power Electronic Converter. [10]

   B Explain the operation of three level Diode clamped Multilevel inverter. [10]

APPENDIX - I

Physical, Electrical and Magnetic characteristics of ferrite cores

CORES without air gap	mean length per turn l_t mm	mean magnetic length l_e mm	core cross section area $A_e \times 100$ mm^2	window area $A_w \times 100$ mm^2	area product $A_p \times 10^4$ mm^4	effective relative permeability $\mu_r \pm 25\%$	A_L nH/turns^2 $\pm 25\%$
POTCORES - CEL HP$_3$C grade, (*Philip 3B7 grade)							
P 18/11	35.6	26	0.43	0.266	0.114	1480	3122
P 26/16	52	37.5	0.94	0.53	0.498	1670	5247
P 30/19	60	45.2	1.36	0.747	1.016	1760	6703
P 36/22	73	53.2	2.01	1.01	2.010	2030*	9500*
P 42/29	86	68.6	2.64	1.81	4.778	2120*	10250*
P 66/56	130	123	7.15	5.18	37.03		
EE - CORES - CEL HP$_3$C grade							
E 20/10/5	38	42.8	0.31	0.478	0.149	1770	1624
E 25/9/6	51.2	48.8	0.40	0.78	0.312	1840	1895
E 25/13/7	52	57.5	0.55	0.87	0.478	1900	2285
E 30/15/7	56	66.9	0.597	1.19	0.71		
E 36/18/11	70.6	78.0	1.31	1.41	1.847	2000	4200
E 42/21/9	77.6	108.5	1.07	2.56	2.739	2100	2613
E 42/21/15	93	97.2	1.82	2.56	4.659	2030	4778
E 42/21/20	99	98.0	2.35	2.56	6.016	2058	6231
E 65/32/13	150	146.3	2.66	5.37	14.284	2115	4833
UU - CORES							
UU 15	44	48	0.32	0.59	1.190		1100
UU 21	55	68	0.55	1.01	0.555		1425
UU 23	64	74	0.61	1.36	0.823		1425
UU 60	183	184	1.96	11.65	22.83		1900
UU 100	29.3	308	6.45	29.14	187.95		3325
TOROIDS - CEL HP$_3$C							
T 10	12.8	23.55	0.062	0.196	0.012	2300	775
T 12	19.2	30.40	0.12	0.442	0.053	2300	1180
T 16	24.2	38.70	0.20	0.785	0.157	2300	1482
T 20	25.2	47.30	0.22	0.950	0.213	2300	1130
T 27	34.1	65.94	0.42	1.651	0.698	2300	1851
T 32	39.6	73.00	0.61	1.651	1.010	2300	2427
T 45	54.7	114.50	0.93	6.157	5.756	2300	2367

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APPENDIX - II

Wire Size Table

SWG	Dia with enamel mm	Area of bare conductor mm²	R/Km @20°C ohms	Weight Kg/km
45*	0.086	0.003973	4340	0.0369
44	0.097	0.005189	3323	0.0481
43	0.109	0.006567	2626	0.0610
42	0.119	0.008107	2127	0.0750
41	0.132	0.009810	1758	0.0908
40*	0.142	0.011675	1477	0.1079
39	0.152	0.013700	1258	0.1262
38*	0.175	0.018240	945.2	0.1679
37	0.198	0.023430	735.9	0.2202
36	0.218	0.029270	589.1	0.2686
35*	0.241	0.035750	482.2	0.3281
34	0.264	0.04289	402.0	0.3932
33	0.287	0.05067	340.3	0.4650
32*	0.307	0.05910	291.7	0.5408
31	0.330	0.06818	252.9	0.6245
30	0.351	0.07791	221.3	0.7121
29*	0.384	0.09372	184.0	0.8559
28	0.417	0.11100	155.3	1.0140
27	0.462	0.13630	126.5	1.2450
26*	0.505	0.16420	105.0	1.4990
25	0.561	0.20270	85.1	1.8510
24*	0.612	0.24520	70.3	2.2330
23	0.665	0.29190	59.1	2.6550
22*	0.770	0.39730	43.4	3.6070
21	0.874	0.51890	33.2	4.7020
20*	0.978	0.65670	26.3	5.9390
19	1.082	0.81070	21.3	7.3240
18*	1.293	1.16700	14.8	10.5370
17	1.501	1.58900	10.8	14.3130
16	1.709	2.07500	8.3	18.6780
15	1.920	2.62700	6.6	23.6400
14*	2.129	3.24300	5.3	29.1500
13	2.441	4.28900	4.0	38.5600
12	2.756	5.48000	3.1	49.2200
11	3.068	6.81800	2.5	61.0000
10	3.383	8.30200	2.1	74.0000
9	3.800	10.5100	1.6	94.0000
8	4.219	12.9700	1.3	116.0000

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(3 Hours) **[Total Marks: 80]**

(1) Question No.1 is compulsory
(2) Attempt any three from the remaining
(3) Figures to the right indicate full marks

			Marks
Q.1		Solve **ANY FOUR** questions from following. (Each question carries 5 marks)	**(20)**
	a)	State and explain the parameters related to batteries 1) C-rating 2) Depth of Discharge.	
	b)	What are different ways to use solar thermal energy? Summarize anyone in brief with the help of diagram.	
	c)	Discuss the working of micro-hydro power plant.	
	d)	Compare advantages and disadvantages of Horizontal axis wind turbine (HAWT).	
	e)	Summarize solid oxide fuel cell with the help of diagram.	
Q. 2	**a)**	With neat diagram explain the working principle of solar concentrators.	**(10)**
	b)	Discuss Latent Thermal Energy storage. Demonstrate how solar power can be stored by using Latent heat energy storage.	**(10)**
Q. 3	**a)**	Analyze the impact of change in solar radiation and temperature on solar PV Characteristics with a neat figure.	**(10)**
	b)	Discuss the mismatch in PV module and the phenomenon of hotspots.	**(10)**
Q.4	**a)**	Demonstrate India's reserves of Conventional and Non-Conventional energy resources. Draw the current generation status of different energy alternatives. What is the impact of CO2 emissions in the environment?	**(10)**
	b)	Interpret working of Wind energy system (WES) with its various components. What are different power converter topologies used for WES? Explain anyone in detail.	**(10)**
Q.5	**a)**	What are the different types of fuel cells available? Compare the features of each with neat diagrams.	**(10)**
	b)	Discuss the different topologies used in fuel cell power system.	**(10)**
Q.6	**a)**	Summarize the following technologies: i) Wave energy ii) Tidal Energy	**(10)**
	b)	Interpret the working principle of geothermal energy conversion. Write its advantages and disadvantages	**(10)**

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