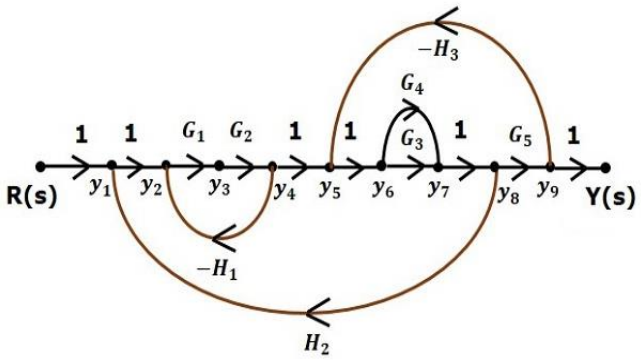
Time- 3 Hours **Marks:80**

1. Question no. 1 is compulsory
2. Solve any three questions out of remaining five questions
3. Figures to the right indicate full marks
4. Solve any four questions out of remaining six questions

Q. 1	Solve any four	Marks
A)	Define stability, instability in the form of crossover frequencies, GM and PM from Bode diagram.	05
B)	Plot the roots in s- plane for over damped, under damped, critically damped and un-damped system.	05
C)	Compute the transfer function from state space model if A= $\begin{bmatrix} 0 & 1 \\ -3 & -8 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ C= [3 4] $D = 0$	05
D)	Using Routh's stability criterion determine the range of K, so that system remain stable for unity feedback system in which open loop system is given by G(S)H(S)=K/S(1+S)(1+2S)	05
E)	Find out breakaway point for the root locus of open loop transfer function G(S)=K/S(S+2)(S+4)	05
Q 2 A)	Derive the relation for output time response for second order undersamped underdamped system for the step input of magnitude 2 units.	10
B)	Find out all time domain parameters for the second order underdamped transfer function C(S)/R(S)= 12(S^2 + 4S +8). Also find out expression of output response.	10
Q 3 A)	Using Mason's gain formula find out transfer from the given signal flow graph	10



B) Sketch the complete Polar plot and comment on stability for $G(S)= 1/S(S+1)(2S+1)$ 10

Q 4 A) Draw complete root locus and comment on stability for unity feedback system 10

$$G(S)= K/S(S+3)(S^2 + 3S+4.5)$$

B) Obtain state model of the transfer function $T(F)= (S^2+3S+3)/(S^3+2S^2+3S+1)$. Draw signal flow graph. 10

Q 5 A) Find Type of a system, all error constants and find steady state error for unit parabolic input. 10

$$G(S)=1000(S+2)/S(S^3+7S^2 +12S)$$

B) Draw Bode plot and comment on stability for $G(S)= 100/S(S+2)(S+5)$ 10

Q 6 A) For unity feedback system, determine resonance peak and resonance frequency. 10

$$G(S)=100/S(S+5)$$

B) Construct the complete Nyquist plot for a unity feedback control system whose open loop transfer function is $G(S)H(S)= K/S(S^2 +2S+2)$. Find the value of K for which the system is stable. 10

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

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

1.	(a)	List out the solar PV technologies and illustrate anyone solar PV technology.	**20**
	(b)	Explain the role of renewable energy and energy storage systems in a futuristic power system scenario.	
	(c)	Write a short note on Solar concentrators.	
	(d)	Illustrate the advantages and disadvantages of vertical axis wind turbine (VAWT).	
2.	(a)	Explain in detail Battery charge controllers and Power Conditioning Unit in solar PV system.	**10**
	(b)	Discuss the power converter used for Doubly fed Induction Generators in wind turbines.	**10**
3.	(a)	Illustrate the significance of MPPT in PV system. Explain perturb and observe MPPT algorithm with the help of suitable diagram.	**10**
	(b)	Explain the working principle of geothermal energy conversion. Write its advantages and disadvantages.	**10**
4.	(a)	Explain the types of wind turbine and Wind turbine characteristics.	**10**
	(b)	Describe solar Flat plate collectors with the help of a neat diagram. State any one application.	**10**
5.	(a)	Describe the electrical power generation with the following technology in brief: Microhydro power plant.	**10**
	(b)	State the effect of the following on solar PV system performance i) Mismatch in modules ii) Blocking diode.	**10**
6.	(a)	Explain the principles of the following technologies i) Wave energy ii) Biomass energy.	**10**
	b)	Discuss Alkaline Fuel cell along with two advantages and disadvantages.	**10**

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Time : 3 Hours **Marks:80**

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** the following

A Discuss the advantages of Switched Mode Power Supply (SMPS) as compared with Linear Power Supplies. [5]

B Which core material would you select for making an inductor in a dc-dc converter operating at 100kHz. State the advantages and justify the material selection. [5]

C What is the need for resonant converters? List any three applications of resonant converters. [5]

D In a step-up converter, the duty ratio is adjusted to regulate the output voltage at 48 V. The input voltage varies in a wide range from 12 to 36 V. The maximum power output is 120W. It is required to operate the converter always in discontinuous conduction mode (DCM) for stability reasons. The switching frequency is 50 kHz. Assuming ideal components and C as very large, calculate the maximum value of input inductor that can be used. [5]

E List the PWM techniques of Multilevel Inverter and briefly describe any one PWM technique. [5]

2 A In a Boost dc-dc converter, Output voltage = 36V (regulated), Input voltage=12V, switching frequency= 40kHz, output power=100W, L=100µH. Find (i) duty cycle; (ii) output current & input current; (iii) ripple in inductor current; iv) switch conduction time in each cycle and (v)Value of capacitor considering 1% ripple in output voltage. All components are ideal. [10]

B What are the three types of Multilevel inverter? Describe the operation of single phase three level Diode Clamped Multilevel Inverter. [10]

3 A With a block diagram or neat diagrams describe any one application of power electronic converter. Comment on the converter selection in the application. [10]

B A Boost DC-DC converter in CCM has the following specifications: [10]

V_{in}=40V, I_{in}=2A, f_s=50kHz, V_{out} =60V, R_{load}=45Ω.

Assume B_m=0.2T, Kw=0.6, J=3A/mm^2, K_c=1, Consider ripple in inductor current (Δi_L) =10% of average inductor current. All components are ideal.

1. Select a suitable core for the inductor
2. Find the number of turns needed for the inductor
3. Find the wire size (SWG)
4. Will the winding fit in to the available window area?

Refer Appendix I & II for selection of core size and wire size.

4 Derive the state space averaged model of an ideal Buck converter operating in CCM from the state space equations during ON state and OFF state. Find the transfer function and select a compensator for the regulation of output voltage for the parameters given below. Parameters of Buck converter: Vin= 12V, Vout =5V, Io=4A, L=150µH, C=10µF, switching frequency=40kHz. [20]

5 A Describe the operation of any one isolated dc-dc converter and derive the output to input voltage ratio. [10]

B In a flyback converter in CCM, input voltage = 24V, output voltage =5V, N_1/N_2 =3, Magnetizing inductance=500μH, load resistance=5Ω, switching frequency =40kHz. Calculate: i) Duty cycle, ii) input current; iii) magnetizing inductor current iv) ripple in magnetizing inductor current and (v) maximum and minimum magnetizing inductor current. Assume ideal components. [10]

6 A Describe the operation of any one resonant switch converter where power loss is zero, during switching ON and OFF of the switching device. [10]

B State the advantages of digital control of dc-dc converters. Compare current control and voltage control methods of dc-dc converter. [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_m mm	core cross section area $A_c \times 100$ mm²	window area $A_w \times 100$ mm²	area product $A_p \times 10^4$ mm⁴	effective relative permeability $\mu_r \pm 25\%$	A_L nH/turns² ±25%
POTCORES - CEL HP_3C 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_3C 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_3C

T 10	12.8	23.55	0.062	0.196	0.012	2300	765
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

APPENDIX - II

Wire Size Table

SWG	Dia with enamel mm	Area of bare conductor mm^2	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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