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

N.B.: (1) Question No. **1** is **compulsory.**
(2) Answer any **three** from the remaining **five** questions.
(3) **Assume** suitable **data** if necessary and justify the same.

1. (a) What is a dc-dc voltage regulator? Give a comparison between linear power supply and switched mode power supply. **[5]**
   (b) Explain the difference between ZVS and ZCS resonant dc to dc converter with neat circuit diagrams. **[5]**
   (c) What is the need for multilevel inverter? What are its applications? **[5]**
   (d) Discuss any two current control methods in dc to dc converter. **[5]**

2. (a) Draw the diagram of a Boost converter. Find the expression for control to output transfer function of an Ideal Boost converter in CCM using state space averaging technique and small signal analysis. **[20]**

3. With a neat diagram of a Flyback dc to dc converter, design a transformer for the following specifications: input voltage(V_d)=24V, V_o=5V P_o=30W, f_s=40kHz, L_1=1mH. Assume K_w=0.4, ΔB=0.1T, J=3A/mm^2, D_{max}=0.45, η =80%, V_D=1.5. Assume any other data if needed and state the same. **[20]**

4. (a) With neat diagrams explain Push Pull dc to dc converter and derive the voltage ratio **[10]**
   (b) With a neat block diagram write short notes on DC Link voltage control loop and the design of compensator in current mode control of grid connected inverter. **[10]**

5. (a) Explain phase shifted and level shifted PWM technique used in Multilevel inverters **[10]**
   (b) A BUCK- Converter has an input voltage of Edc=14V. The required average output voltage is Eo=6V and the peak to peak output ripple voltage is 15mV. The switching frequency is 30kHz. If the peak to peak ripple current of inductor is limited to 0.6 A. Determine: (a) the duty cycle, (b) the filter inductance L, and (c) the filter capacitor C. **[10]**

6. (a) Draw the steady state characteristics of Series Loaded Resonant dc to dc converter and explain its features. **[10]**
   (b) Explain any one of the following **[10]**
   (i) Thermal management and EMI issues in converters.
   (ii) Solar PV power conditioning unit.
   (iii) Modelling of Grid connected inverter with LC filter

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 $A_c \times 100$ 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_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 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