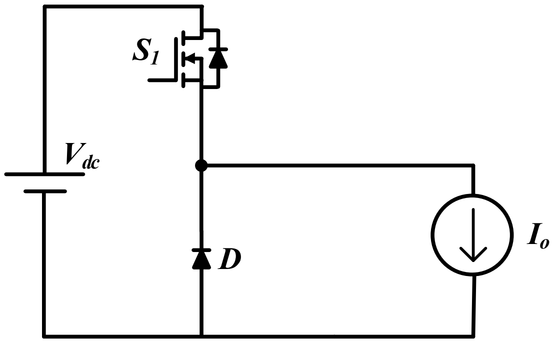
WEEK 3: ASSIGNMENT

1. For the circuit shown below what will be the RMS current (in A) of the switch S_1, if the switch S_1 is turned-on for 20 μs and diode D is turned-on for 5 μs. The switching frequency of the switch is kept at 40kHz, $V_{dc} = 400V$, $I_o = 25A$. The answer should be rounded up to 3 decimal places.



Answer: 22-23

2. If a single-phase PFC converter operating with unity power factor, then output capacitor voltage ripple has following dominant frequency component:

A. line frequency component
B. 2nd line harmonic component
C. switching frequency component
D. 2nd harmonic of switching frequency component

Answer: B

3. The transfer function $\left.\frac{\widetilde{i_l(s)}}{\widetilde{d(s)}}\right|_{|\widetilde{v_s(s)}|=0}$ is obtained from state space representation by following equations:

A. $(SI - A)^{-1}Q$

B. $(SI - A)^{-1}K$

C. $C(SI - A)^{-1}Q$

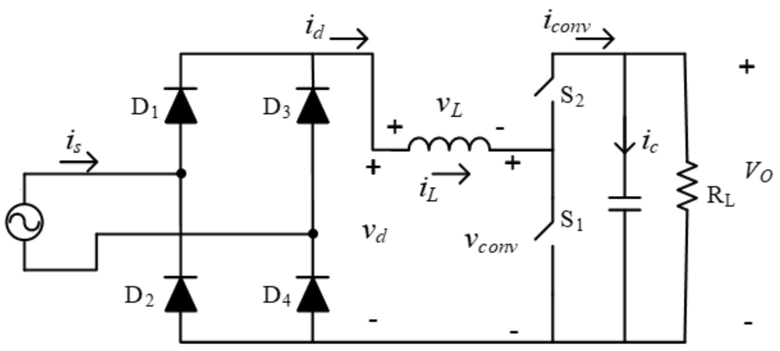
D. $C(SI - A)^{-1}K$

Answer: B

4. A boost PFC converter fed from 220V, 50Hz input is supply the 1000W load. The converter is operated with the switching frequency of 10 kHz and regulates the output voltage at 400V. The allowable peak to peak output voltage ripple is 5% of the nominal. Calculate the smallest capacitance is required to meet the specification in μF. (Note: The answer should be rounded up to 2 decimal places; use $\pi = 3.14$; $1\ radian = 57.3\ degrees$).

Answer: 397.00 – 400.00

5. For the Boost PFC as shown below.



Match the following:

Switches	RMS current stress
I. S_1	a. $\sqrt{\frac{2}{T}\int_0^{\frac{T}{2}} \mathrm{d}(t)(i_s^2(t))\,dt}$
II. S_2	b. $\sqrt{\frac{2}{T}\int_0^{\frac{T}{2}} (1-\mathrm{d}(t))(i_s^2(t))\,dt}$
III. D_1	c. $\frac{I_{s,pk}}{2}$
IV. D_2	d. $\frac{I_{s,pk}}{\sqrt{2}}$

A. I -a, II-b, III-c, IV-c
B. I -b, II-a, III-c, IV-c
C. I -b, II-a, III-d, IV-d
D. I -a, II-b, III-d, IV-d

Answer: A

6. If, while doing small signal modelling to obtain the transfer function, following are the steps involved:

I. Average large signal model
II. Linearization around the operating point
III. Perturbations
IV. Conversion from time domain to s-domain

Then what will be the correct order in which the above mentioned steps need to be arranged to obtain the transfer function.

A. I, II, III, IV
B. IV, III, II, I
C. I, III, II, IV
D. IV, III, II, I

Answer: C

7. For the table shown below:

Matrices	parameters
I. A_1	a. $\begin{bmatrix} 0 & -\frac{1}{L} \\ \frac{1}{C} & -\frac{1}{R_L C} \end{bmatrix}$
II. A_2	b. $\begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix}$
III. B_1, B_2	c. $\begin{bmatrix} 0 & 0 \\ 0 & -\frac{1}{R_L C} \end{bmatrix}$
IV. C_1, C_2	d. $[0 \quad 1]$

Match the correct combination (Symbols have obvious meanings):

A. I -a, II-c, III-b, IV-d
B. I -c, II-a, III-b, IV-d
C. I -a, II-c, III-d, IV-b
D. I -c, II-a, III-d, IV-b

Answer: B

8. For dual loop closed control of PFC converter, which of the following statements is/are true:
A. The outer loop is the output DC voltage control loop
B. The inner loop is the supply current control loop
C. The outer loop is the supply current control loop
D. The inner loop is the output DC voltage control loop

Answer: A, B

9. Which of the following quantities is/are the state variable in the boost PFC converter?

A. Inductor current
B. Duty ratio
C. Input AC voltage
D. Output capacitor voltage

Answer: A, D

10. Which of the following is/are the correct assumptions which have been taken while obtaining the small signal modelling of the boost PFC converter to obtain the average current control?

A. $f_{sw} \gg f_s$
B. $f_s \gg f_{sw}$
C. Duty ratio at one switching period remains constant
D. magnitude of perturbations $\gg$ operating point values
E. magnitude of perturbations $\ll$ operating point values

Answer: A, C, D

Answer Keys:

1. 22-23	**2. B**	**3. B**	**4. 397.00-400.00**	**5. A**
6. C	**7. B**	**8. A, B**	**9. A, D**	**10. A, C, D**

Assignment #3

Q.1. for the circuit, 'S₁' is ON for 20 μs, and switching frequency of 40 kHz

$$\Rightarrow \quad T_s = \frac{1}{40 \times 1000} = 25\,\mu s$$

$\therefore$ Duty ratio of S_1, $D = \dfrac{20\mu s}{25\mu s}$

$$= 0.8$$

$\therefore$ The RMS current of $S_1 = \sqrt{D} \cdot I_o$ (as it carry constant current)

$$= \sqrt{0.8} \cdot 25$$

$$\boxed{I_{,rms,S1} = 22.36\ A}$$

Assignment # 3

Q.4.

$$C = \frac{P_L}{2\pi f_s \Delta V_o \cdot V_o}$$

, $P_L = 1000W$
$V_o = 400V$
$f_s = 50\ Hz$

$$\Delta V_o = \frac{5}{100} \times 400$$
$$= 20V$$

(5% of nominal)

$$\Rightarrow C = \frac{1000}{2 \times 3.14 \times 50 \times 20 \times 400}$$

$$C = 3.98089 \times 10^{-4}$$

$$\Rightarrow \boxed{C = 398.09\ \mu F}$$

(this is the smallest capacitor as if you increase the capacitor the ΔV_o will be smaller than 5% of nominal, which is ok)