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EV MASTERCLASS CAPSTONE PROJECT

Ladies and gentlemen,

As part of course completion you are requested to complete either of the 3 capstone projects (you could attempt all, but the best would only be considered). Once you make your submission we will evaluate and select the best capstone projects for a day at bosch and an opportunity to present these projects where one of you would win best capstone project award.

Date of Submission: 10/11/2024
Format: PPT with Assumptions, Work and Results (Less than 20 slides)
Also Include a Zip Folder with Relevant Simulation Files and Read Me File.

Capstone Project 1 – Design of Inverters

- Design a Controller for PMSM machine with SvPWM.
  - Explore different control mechanism (Field Oriented Control, Maximum Torque Per Ampere, Flux Weakening).
  - Design a controller for a stable control operation with following torque dynamics (For the below given machine parameters).
    - Peak Overshoot 10% of desired torque.
    - Steady state torque error 6% (average torque)
    - Settling time 250mSec
    - Rise time 50mSec
    - Torque ripple 3% desired torque.

Sl No	Machine Parameter	Value
1	Number of Poles (-)	8
2	Flux Linkage (Wb)	0.185
3	Stator Inductance d-axis (mH)	0.171
4	Stator Inductance q-axis (mH)	0.498
5	DC Link Voltage (V)	400
6	Stator Resistance (ohm)	0.0015

- Estimate the Capacitance value for the defined Inverter spec.:
  - Ref: Link (Analytical calculation of the RMS current stress on the DC link capacitor of voltage DC link PWM converter systems)

Capstone Project 2 – Design of On-Board Chargers

- Build a 230V, 50Hz single-phase full bridge diode rectifier on any simulation platform of your choice, and do the following:
- Calculate the capacitor to be connected for a load (Resistive) current of 1A, ripple voltage of 1%.
- Connect the capacitor calculated in (a) to the diode rectifier and check if the ripple is 1%. If it is not, list the reason for the deviation between simulation and calculation.
- Vary the load such that the load current is 2A and check the value of the ripple in the simulation. Did the ripple change? Justify your observations with calculations.
- Remove the resistive load and connect a simple power converter of your choice so that the output voltage is controllable, by varying the duty ratio.
- Observe the ripple at the output terminals of the diode rectifier and the power converter. Did the ripple vary? Reason out what happens when the resistance is replaced with the power converter.
- Plot THDs all the above cases.
- Please use following reference to help you with the assignment questions.
  - D. W. Hart, “Power Electronics,” McGraw-Hill Companies Inc., New York, 2010.

Capstone Project 3 – Design of DC-DC Converters

1. Design a PSFB in open loop for the specifications shown below and observe the changes in the output voltage for different delay times (a) 45◦, (b) 90 ◦ and (c) 180 ◦.
    a. Hint – https://youtu.be/uIa919l-w6o?si=4r3otanjHMw0h0VO

SL.NO	Specifications	Value
1	Input Voltage, V_g	800 V
2	Output Voltage, V_0	14 V
3	Output Current, I0	160 A
4	Inductor, L	?
5	Capacitor, C	?
6	Switching Frequency, f_s	480 kHz

- Assume D ~ 0.3 and calculate N_2/N_1

$$\frac{V_0}{V_g} = \frac{N_2}{N_1} * 2D$$

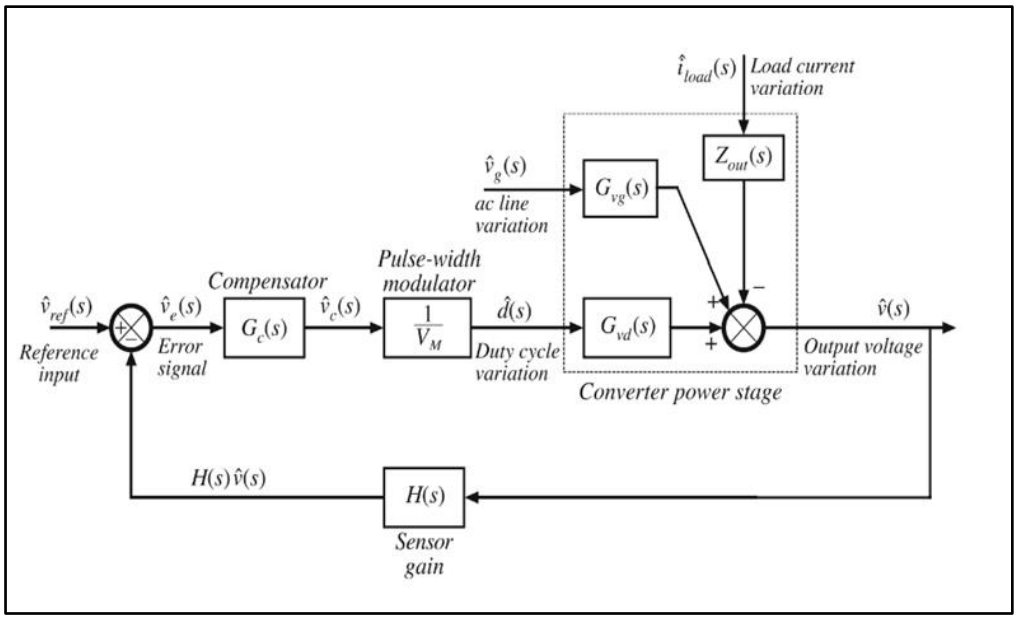
- Assume $\frac{\Delta i_L}{I_L} = 1\%$ $\frac{\Delta V_0}{V_o} = 1\%$ $R = \frac{V_0}{I_0}$ $I_L = \frac{V_0}{I_0}$
- Frequency of the voltage at the secondary is two times that of primary

$$L = \frac{(V_g * \frac{N_2}{N_1} - V_0) * 2D}{2 * f_s * \Delta i_L} \qquad C = \frac{(1-2D)}{8 * L * (2 * f_s)^2 \frac{\Delta V_0}{V_0}}$$

2. Design a single output voltage loop system based on the block diagram by choosing appropriate cross-over frequency. (Hint – Bandwidth < (1/10) f_s)
    a. Settling time < 5 ms and overshoot < 200 mV for
        i. changes in the output voltage from 5V to 10 V at 100 V/ ms
        ii. change in the load at 100 A / ms
    b. Inject HV side ripples of 15 V peak to peak upto 5kHz and LV peak to peak ripple < 150 mV.

    Note: The above conditions shall be satisfied by choosing only one cross-over frequency.

(Refer next page for block diagram)



Use Vm = 4, H = 3.3 / Peak value and develop a transfer function for output voltage to the reference input.

Yours sincerely
Organizers of EV Masterclass