EE/KSSK/03062021/EndSem

Name:…….....
Roll No:…….....

DEPARTMENT OF ELECTRCAL ENGINEERING
National Institute of Technology Calicut

END SEMESTER EXAM- WINTER SEMESTER JUNE 2021

EE6308DSWITCHED MODE & RESONANT CONVERTERS

Time : 2 Hrs **Maximum : 20 Marks**

Answer All Questions

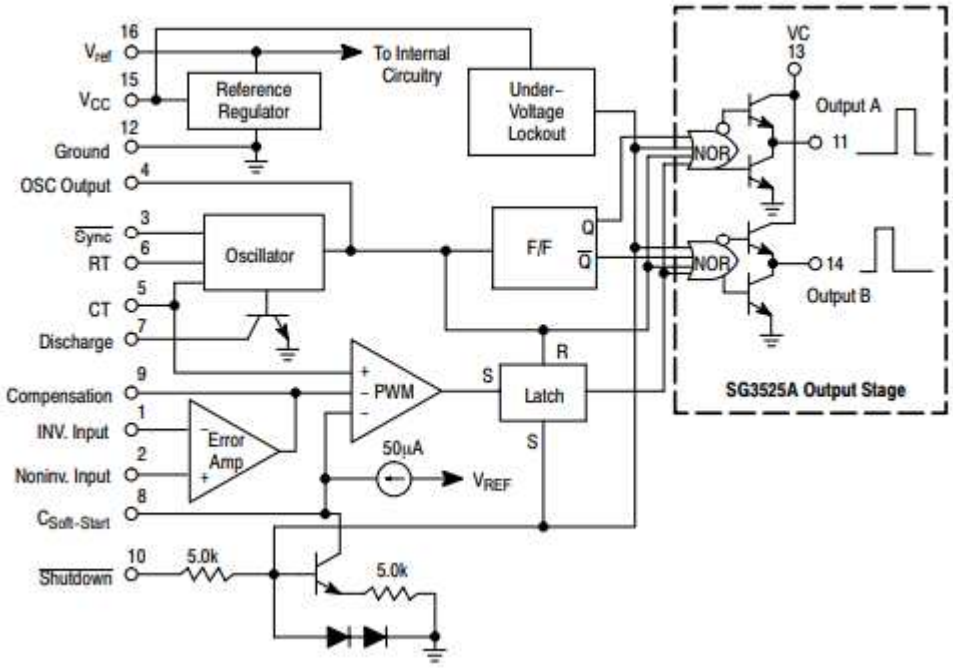
1. (a) **Distinguish between** Running Average, Cycle Average and Local Average of variables in the context of mathematical modelling of SMPS. (0.5 Marks)
   (b) **Explain the role and function** of PWM Modulator that comes after the Compensator and provides drive to the switch. This Modulator is usually taken as a unity gain block in controller analysis. **Discuss** the validity of this assumption. (1.5 Marks)

2. (a) All the three types of compensators commonly employed in Voltage Mode Control of SMPS have a common factor 1/s in their transfer functions. **Explain why** this factor is needed in all compensator transfer functions. (0.5 Marks)
   (b) Two non-isolated Buck Converters with same input voltage and output specifications employ different capacitor sizes. They are otherwise identical. Design-A uses a 1000µF electrolytic capacitor from 80µs family and Design-B uses a 125µF from 10µs family. Voltage Mode Control is used in both. It is seen that when designed for the same phase margin of 60 deg, one of them needs a Type-3 compensator whereas the other requires only a Type-2. **Explain** why, starting with the control-to-output transfer function of a Buck Converter? **Identify** which design will require Type-3 compensator with justification for your decision. (1.5 marks)

3. (a) **Explain the different factors** that lead to a choice of gain crossover frequency in the design of compensators for Voltage Mode Control of SMPS. (1 Mark)
   (b) The Professor who teaches SMRC to you says – "A Buck Converter that is ideal, that is, with zero resistances in inductor, capacitor, switch and diode, *requires* a Type-3 Compensator for *any positive phase margin value*. Type-1 and Type-2 simply will not be enough in this case." Starting with Buck Converter control-to-output transfer function, **show that** what he stated is correct. (1 Mark)

4. (a) **Explain how** Current Mode Control is implemented ? **List and explain** all the advantages of Current Mode Control. (1 ½ Marks)
   (b) **What is** meant by Subharmonic Instability in CMC? **How** is it prevented? (1 Mark)
   (c) **Explain the design procedure** for designing the Outer Voltage Control Loop in the case of a Buck Converter under Current Mode Control? (1 ½ Marks)

5. A representative diagram of a PWM Control IC SG3525 is shown below. (4 x 1 = 4 Marks)
   (a) Explain the functions of the under-voltage lockout, latch and the flip flop.
   (b) Explain how a Type-2 Compensator can be implemented by using the Error amplifier.
   (c) Explain how soft start control is achieved when this IC is used.
   (d) Explain how a Boost Converter with a duty ratio requirement range of [0.5 0.65] can be driven by a SG3525.



6. A Boost Converter data is given : 5V input, 12V/2A resistive load output, 50kHz Switching, L = 30uH/0.05 Ω, C = 1000µF/0.01Ω, Switch Resistance and Diode resistance = 0.05Ω, Diode Cut-in Voltage = 0.5V.

   (a) **Find the Control-to-Output transfer function** around an operating point 5V input, 12V 2A Output. Use d_o = 0.64 in evaluating transfer function. You do not have to derive equations and you may refer to class notes. (0.5 marks)

   (b) Choose a gain crossover frequency of 5kHz. **Find the maximum phase margins** that can be realized with this crossover frequency if Type-3 VMC Compensator is employed. (1 Mark)

   (c) **Design a Type-3 compensator** function such that crossover frequency is 5kHz and Phase Margin of the closed loop system is 60 deg. (1 Mark)

   (d) Assuming the error signal, i.e, (V_o - 12) is available as input, **design** an Opamp based circuit to implement this compensator function and **show the circuit** with component values marked. (1.5 Marks)

7. **Explain** how the Shunt Regulator diode TL 431 can be used to feedback output voltage without breaking isolation barrier in a SMPS. **Draw** the circuit diagram for a Voltage Mode PI Controller using TL431 and an Optocoupler and explain how to arrive at component values. (2 Marks)

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