BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.TECH/PRE-PHD **SEMESTER : II**
BRANCH: EEE **SESSION : SP/2023**

SUBJECT: EE561 EMBEDDED CONTROL OF SWITCHING POWER CONVERTER

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Differentiate between linear power supply and switched mode power supply.	[5]	1	1
Q.1(b)	List two application of SMPS in renewable energy harnessing.	[5]	1	1
Q.2(a)	Explain the method for determination of Proportional-Integral (PI) controller gain in case of Boost converter using an appropriate flow chart.	[5]	2	2
Q.2(b)	Relate small signal change in output voltage $(\hat{V}_C)$ and small signal change in the input duty cycle $(\hat{d})$ in case of Boost Converter by obtaining a transfer function.	[5]	2	2
Q.3(a)	Analyze the impact of the integral windup error on the time domain dynamics of the DC-DC converter.	[5]	3	3
Q.3(b)	Analyze the effect of sub-harmonic oscillations on the stability of Digital-PWM DC-DC converters with the help of voltage and current waveform.	[5]	3	3
Q.4(a)	Develop a small signal model of the buck converter.	[5]	4	4
Q.4(b)	Compute full state feedback controller gain of following small signal model of buck converter.	[5]	4	4

$$\begin{bmatrix} \dot{\hat{e}}_1 \\ \dot{\hat{e}}_2 \end{bmatrix} = \begin{bmatrix} 0 & 3 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} \hat{e}_1 \\ \hat{e}_2 \end{bmatrix} + \begin{bmatrix} -2 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} \hat{V}_{DC} \\ \hat{d} \end{bmatrix}$$

Where, $\hat{e}_1$ = small signal error between the desired inductor current and actual inductor current
$\hat{e}_2$ = small signal error between the desired capacitor voltage and actual capacitor voltage.
$\hat{V}_{DC}$ = small signal change in input DC voltage
$\hat{d}$ = small signal change in duty cycle

Q.5(a)	Code an ATMEGA2560 microcontroller in order to capture analog voltage signal using ADC registers.	[5]	5	5,6
Q.5(b)	Design an embedded system block diagram for closed-loop voltage control of DC-DC Buck converter	[5]	5	5,6

::::::25/04/2023::::::E