



K. K. Wagh Institute of Engineering Education & Research, Nashik
(An Autonomous Institute From A.Y. 2022-23)

WINTER-2025	
Exam Seat No.:	
Academic Year:2025-2026	Semester:VII
Class:FINAL	Program:B.Tech
Branch Code:ELE	Pattern:2022
Name of Course:Design of Power Electronic Converter	Course Code:ELE224002B
Max. Marks:60	Duration:2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 04 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.

Marks CO

Question No. 1

- 1a) Design a buck converter with input voltage 50V to the load of 200W at output voltage 25V. The ripple in output current is 10% and in output voltage is 1%. The switching frequency is 100kHz. Calculate (6) CO1
- (i) Duty cycle
 - (ii) Load current and ripple in inductor current
 - (iii) Inductor rating
 - (iv) Capacitor rating

Question No. 2

- 2a) Read the datasheet of scotty diode 1N5819 provided with this paper and answer the following: (6) CO2
- (i) RMS Voltage rating of the diode= _____
 - (ii) Forward voltage drop at 3A= _____
 - (iii) Typical junction capacitance= _____
 - (iv) Blocking voltage capability of diode= _____
 - (v) Junction to ambient thermal resistance= _____
 - (vi) Junction to case thermal resistance= _____

Question No. 3

3a) What is the need of isolation in gate driver? Explain optical isolation with diagram. (6) CO1

OR

3b) What are the causes of high dv/dt and di/dt in power electronic circuits? What the impact of high di/dt and dv/dt on device operation? How it can be reduced? (6) CO2

3c) Read the data sheet of IGBT STGW30NC120HD provided with this paper and solve the following problem of design of Gate Driver. (10) CO3

(i) From data sheet, what is the value of positive gate to emitter voltage (V_{GE}) and the maximum value of gate the emitter threshold voltage ($V_{GE(th)}$) ? →(1 Mark)

(ii) Calculate current during interval 1, 2 and 3 in turn on process, if $V_{GE(emitter)}$ is 7.5V, V_{GEOFF} is -5V, driver side switch resistance is 1.5 ohm, external gate resistance is 2.5 Ohm and internal gate resistance is 2 Ohm. →(3 Marks)

(iii) From data sheet, what are the values of input, output and reverse transfer capacitance? →(1.5 Marks)

(iv) Time interval 2 and 3 during turn on. →(2 Marks)

(v) From data sheet, what is the total gate charges (Q_g) →(1 Mark)

(vi) If switching frequency is 75kHz, calculate gate power loss and power loss in gate driver IC →(1.5 Mark)

OR

3d) The STF24N60M2 MOSFET is used in a buck converter. One MOSFET is used like a switch by giving gate pulses. Second MOSFET is used like a diode i.e. its body diode is only used and no gate pulse is given. The input voltage of the buck converter is 250V. The value of parasitic inductance is estimated as $L_p = 10nH$. The corresponding damping factor and initial current factor are 0.4 and 2 respectively. (10) CO3

Read the data sheet of MOSFET STF24N60M2 provided with this paper and solve the following problem of design of RC snubber circuit.

(i) From data sheet, what is the value of dv/dt of the device (body diode) ? →(1 Mark)

(ii) From data sheet, what is the typical value of reverse recovery charge (Q_{rr}) of the device ? →(1 Mark)

(iii) From data sheet, what is the typical value of reverse recovery time (t_{rr}) of the device ? →(1 Mark)

(iv) Calculate reverse recovery current. ? →(2 Mark)

(v) Calculate the peak voltage if safety factor is 2. ? →(1 Mark)

(vi) Calculate the snubber capacitance? →(2 Mark)

(vii) Calculate the snubber resistance? →(2 Mark)

Question No. 4

4a) What are the different power losses in a buck converter? (6) CO1

OR

4b) List different types of magnetic cores used in inductor design? Explain any two with diagrams. (6) CO1

4c) A buck converter is designed using STF24N60M2 MOSFET. Following are the specifications of the converter (10) CO3

Input voltage=250V, Output voltage=125V, Switching frequency=50kHz, Ambient temperature 60 degree C, average inductor current 12A, assume switch current 6A.

Read the data sheet of STF24N60M2 MOSFET provided with this paper and solve the following problem of thermal management in the MOSFET.

- (i) According to data sheet, on-state drain to source resistance=____.→(1 Mark)
- (ii) According to data sheet, Typical turn-on time of MOSFET=____→(1 Mark)
- (iii) According to data sheet, Typical turn-off time of MOSFET=____→(1 Mark)
- (iv) According to data sheet, Maximum operating junction temperature=____→(1 Mark)
- (v) According to data sheet, Junction to case thermal resistance=____→(1 Mark)
- (vi) MOSFET conduction loss=____→(1 Mark)
- (vii) MOSFET switching loss=____→(1 Mark)
- (viii) MOSFET total loss=____→(1 Mark)
- (ix) Sink to ambient thermal resistance (neglect case to sink thermal resistance) =____→(2 Marks)

OR

4d) An inductor of 60 uH need to be designed for a buck converter. The current rating of the inductor is 18A with ripple of 0.4 A. Following specifications are chosen for the design. (10) CO3

$B_m=0.2$ T, $J_m=3A/sq.mm$, Window fill factor $K_u=0.4$

Use the data sheets of magnetic cores and AWG for design of the inductor. Answer the following

- (i) Calculate peak current and the energy stored in the inductor. →(1 Mark)
- (ii) Find the area product. →(1 Mark)
- (iii) From the magnetic core data sheet, select the required core. Give the part number of the selected core. →(1 Mark)
- (iv) What is the window area of the core? →(1 Mark)
- (v) Find the cross sectional area of the core. →(1 Mark)
- (vi) Find the magnetic path length of the core. →(1 Mark)
- (vii) Calculate rms value of the current. →(1 Mark)
- (viii) Calculate cross sectional area of the conductor and select AWG conductor from data sheet? →(1 Mark)
- (ix) Calculate number of turns. →(1 Mark)
- (x) If relative permeability is 2300, calculate air gap length. →(1 Mark)

Question No. 5

5a) Write a short note on capacitors in power electronics circuit with its modelling. (6) CO3

OR

5b) Explain the steps used in designing of PCB in power electronic converter. (6) CO3

5c) What is EMI? Explain the radiated and conducted EMI phenomenon in power electronics circuit. (10) CO4

OR

5d) List different methods to reduce EMI in power electronic circuits? Explain any two methods in details. (10) CO4

..... End of question paper.....