Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

END SEM/RE-~~EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: B. Tech. (Electrical)

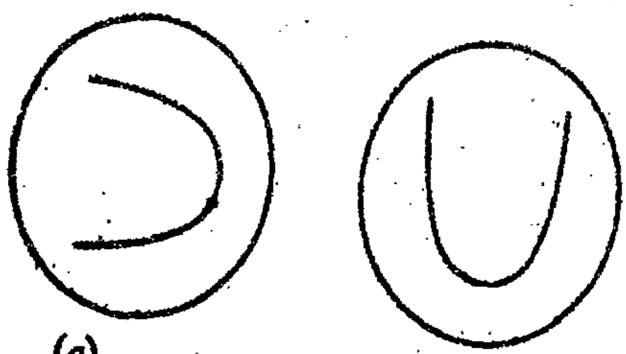
Course Code: PC-BTE501 | **Duration: 3 hrs.**

Course Name: Measurement & Instrumentation | **Maximum Points: 100**

Semester: V

Notes:

1. **Question number 1 compulsory.**
2. Attempt any **four** questions out of remaining **six.**
3. Draw neat diagrams.
4. Assume suitable data if necessary.

Q. No.	Questions	Pts.	CO	BL	Mod. No.
1. (a)	With the help of neat diagram explain in detail working of duel slope integrating type digital volt meter. What are the advantages of a duel slope integrating DVM over Ramp type DVM?	10	1	L1	5
(b)	Find the frequency of the horizontal plates if the frequency applied to vertical plate is 50 Hz for the pattern shown in figure (a) and (b).  (a) (b)	05	1	L2	4
(c)	Explain in detail a five point calibration method with flow chart.	05	1	L1	7
2. (a)	A Lissajous pattern on the oscilloscope is stationary and has 6 vertical maximum values and five horizontal maximum values. The frequency of horizontal input is 1500 Hz. Determine the frequency of vertical input.	05	1	L1	4
(b)	Prove that $$G_f = 1 + 2\nu + \frac{\Delta\rho/\rho}{\varepsilon}$$	15	2	L3	6

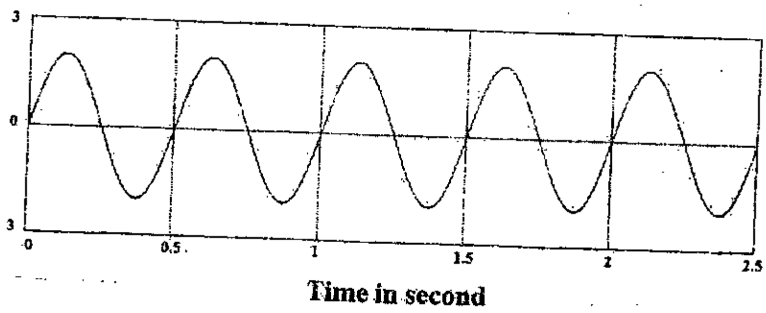
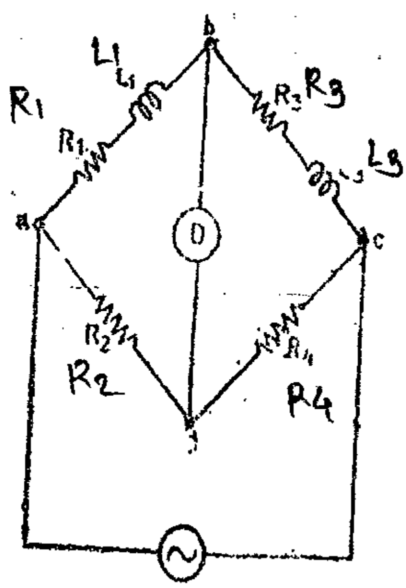
<table>
<tr><td>3. (a)</td><td>Draw null and extreme positions of LVDT transducer to get zero, minimum and maximum output voltage.</td><td>10</td><td>1</td><td>L1</td><td>6</td></tr>
<tr><td>(b)</td><td>With the help of neat diagram explain in detail how to measure frequency of given signal using digital frequency meter?

</td><td>10</td><td>3</td><td>L2</td><td>5</td></tr>
<tr><td>4. (a)</td><td>Draw and explain the nature of equivalent circuit and corresponding phasor diagram of a current transformer. Derive expressions for the corresponding ratio error.</td><td>10</td><td>1</td><td>L1</td><td>3</td></tr>
<tr><td>(b)</td><td>An inductance of 0.22 H and 20 Ω resistance is measured by comparison with a fixed standard inductance of 0.1 H and 40 Ω resistance. They are connected as shown in Fig.1. The unknown inductance is in arm ab and the standard inductance is arm bc, a resistance of 750 Ω is connected in arm cd and a resistance whose amount is not known is in arm da. Find the resistance of arm da and show any necessary and practical addition required to achieve both resistive and inductive balance.


Fig. 1</td><td>10</td><td>2</td><td>L3</td><td>2</td></tr>
</table>

5. (a)	With the help of neat diagram explain in details construction and working principal of Megger.	10	1	L1	2
(b)	Describe the working principle of the harmonic distortion analyzer. How does it measure the harmonic content of a signal, and what are its typical applications in engineering?	10	1	L2	4
6.	With the help of neat diagram explain in details how to measure water level by using following methods. a. Resistive method b. Inductive method c. Capacitive method	20	2	L2	6
7. (a)	With the help of neat diagram explain in detail how to measure time interval between two events digitally?	10	1	L1	5
(b)	Two watt meters are connected to measure the power consumed by a 3-phase load with a power factor of 0.35. Total power consumed by the load, as indicated by the two watt meters, is 70 kW. Find the individual wattmeter readings.	05	3	L3	1
(c)	Explain the term 1. Sampling and holding 2. Quantizing and encoding	05	1	L1	5

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End/Re examination December/January 2024-2025

Program: B. Tech Electrical | **Duration: 3 Hr**

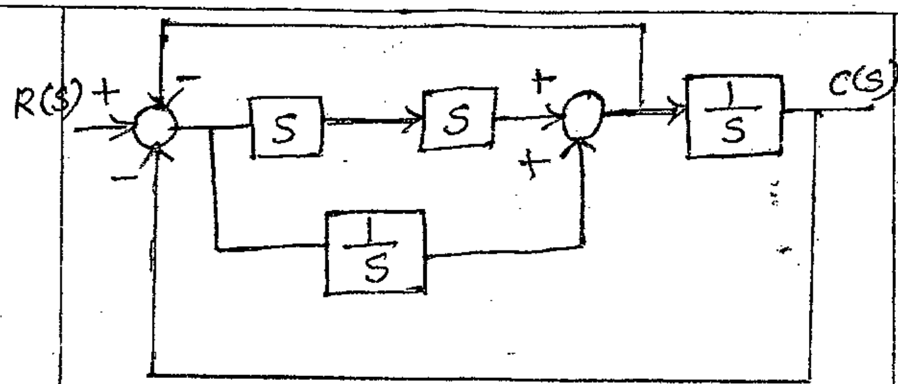
Course Code: PC-BTE 502 | **Maximum Points: 100**

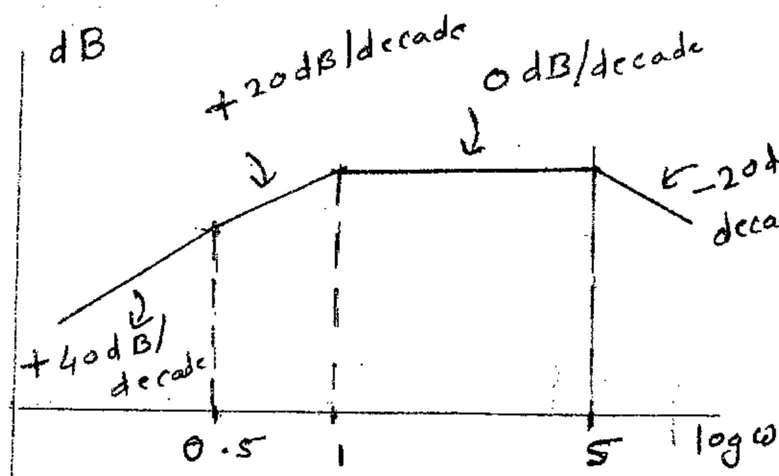
Course Name: Control System | **Semester: V**

Note: Question 1 is compulsory. Attempt any four questions out of remaining six questions

Assume suitable data if required.

Q. No	Questions	Points	CO	BL	Module No
1	a. Why are the compensators required in control systems? b. Write state space equations for series RLC circuit c. What is root locus? What all information is provided by root locus. d. With the help root locus explain system behavior with and without lag compensator. e. What will the step response of second order system in common if (i) The pole is moved with constant imaginary part (ii) Athe pole is moved with constant real part (iii) If the pole is moved along radial line extending from origin. Justify (i), (ii), (iii).	4 4 4 4 4	1_4	1-2	5 6 3 5 2
2 a.	The state space equation is given below $\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad y = [0 \ 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ The initial conditions $x_1(0) = 1$ *and* $x_2(0)=0$ Determine the (1) Transfer function (2) $x_1(t)$ *and* $x_2(t)$ for a unit input Comment if the system is stable or not	10	1	03	06
b	Find the equivalent transfer function T(s)= C(s)/R(s) using (i) Block diagram reduction and (ii) Signal flow graph	10	1	3	1

					
3 a	The open loop transfer function is given by $$G(s)H(s) = \frac{k}{(s+1)(s+2)(s+3)(s+4)}$$ Sketch root locus and find the following (i) Asymptotes (ii) Break away points (iii) The range of k for stability	12	2	3	3
b	For the following transfer function plot pole, zero on s plane. Determine the step response. State the nature of the response. Find damping ratio and natural frequency. Determine 2% settling time and peak time $$T(s) = \frac{20}{s^2 + 6s + 144}$$	10	2	3	2
4 a	For a unity feedback system the open loop transfer function is given by $$\frac{k}{(s^2 + 6s + 25)(s+2)(s+4)}$$ Determine if the closed loop system is stable or not	10	2		3

b	A unity feedback system has open loop transfer function $$G(s) = \frac{K}{s(s+2)}$$ Calculate the value of gain K so that closed loop system has a steady state error to unit ramp input is 0.1. Determine corresponding damping factor and %overshoot.	10	2		2
5 a	Sketch Bode plots showing magnitude in dB and phase angle in degrees as a function of log frequency for the transfer function given below. Determine gain and phase margin. $$G(s) = \frac{10000s^2}{(1+0.2s)(1+0.02s)}$$	14	3		4
b	For the following Bode magnitude response find the transfer function. The system is minimum phase system 	06	3		4
6 a	The open loop transfer function is given by $$G(s)H(s) = \frac{(s+2)}{(s+1)(s-1)}$$ Using Nyquist stability criteria determine stability of closed loop system	10	3	3	4

b	The open loop transfer function is given by $$G(s)H(s) = \frac{6}{s(s^2 + s + 4)}$$ Using Nyquist stability criteria determine stability of closed loop system	10	3	3	4
7	Discuss a> Non linearity b> PI controller c> PD controller d> Lead Lag compensator	20	4	1	5,7

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END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: T. Y. B. Tech | **Duration:** 03 Hour

Course Code: MC-BTE 003 | **Maximum Points:** 100

Course Name: Environmental Science | **Semester:** V

Notes: 1. Attempt **any FIVE** questions.

2. Draw neat diagrams wherever possible.

Q.No.	Questions	Points	CO	BL	Module No.
Q. 1(a)	What is Environmental Engineering/Science? and explain its importance. State different environmental pollutions and hence discuss control strategies of different environmental problems.	01+02 01+06	01	L-1	01
Q. 1(b)	Explain the importance of biotic and abiotic environment. How do biotic and abiotic factors maintain balance in an ecosystem? Hence, state the difference between Biotic and Abiotic Environment.	02 03 05	01	L-1	01
Q. 2 (a)	Explain working principle of following renewable energy sources: 1) Solar Energy 2) Wind Energy	10	01	L-1	02
Q. 2 (b)	Explain environmental impact and economic impact of geothermal and tidal energies.	10	01	L-1	02
Q. 3 (a)	What is sustainable energy management? Explain it in detail. Explain different sustainable technologies that help to reduce environmental impact.	02 08	01	L-1	03
Q. 3 (b)	What do you understand by carbon credits? How to earn carbon credits? Explain the different methods to monitor carbon emission.	01+02 07	01	L-1	03

END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Q. 4 (a)	What are the green commodities? Hence explain the sustainable development in green commodities.	02 08	01	L-1	03
Q. 4 (b)	Explain different causes of mechanical hazards and fire hazards.	10	02	L-1	04
Q. 5 (a)	Explain hazard analysis objectives and its prevention and safety management from environmental safety point of view.	04 06	02	L-1	04
Q. 5 (b)	Describe ISO 14000 Standard for environmental management and safety management.	10	02	L-1	04
Q. 6 (a)	Explain an evolution tool 'GRIHA' (Green Rating for Integrated Habitat Assessment) to help design, build, operate and maintain a resource efficient build environment.	10	04	L-1	05
Q. 6 (b)	Explain GRIHA Assessment criteria to ensure that construction project reduces its overall environmental impact.	10	04	L-1	05
Q. 7 (a)	Write short notes on the following. (1) Case study on GRIHA registered building in India. (2) Solid waste management.	05 05	04 01	L-1	05 01
Q. 7 (b)	Write short notes on the following. (1) Safety measures to avoid mechanical and fire hazards. (2) Yellow Fish Road Project	05 05	02 01	L-1	04 01

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END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: T.Y. B. Tech Electrical | **Duration: 03 Hours**

Course Code: PC-BTE503 | **Maximum Points: 100**

Course Name: Electrical Machines II | **Semester: V**

Notes: (1) Attempt any five (05) questions.
(2) Draw neat diagrams wherever applicable.

<table>
<tr><th>Q.No.</th><th>Questions</th><th>Points</th><th>CO</th><th>BL</th><th>Module No.</th></tr>
<tr><td>Q. 1(a)</td><td>Explain the terms air-gap power P_g, internal mechanical power P_m and shaft power P_{sh}. How are these terms related with each other? Hence show that P_g : rotor ohmic loss : $P_m = 1 : s : (1-s)$</td><td>10</td><td>01</td><td>L-1</td><td>01</td></tr>
<tr><td>Q. 1(b)</td><td>The power supplied to a 3-phase induction motor is 40 kW and the corresponding stator losses are 1.5 kW. Calculate the net mechanical power developed and the rotor I^2R loss when the slip is 0.04 per unit. What will be the net power developed if the speed of the above motor is reduced to 40% of the synchronous speed by means of external rotor resistors, assuming the torque and stator losses to remain unaltered? Friction and windage losses may be assumed to be 0.8 kW.</td><td>10</td><td>01</td><td>L-1</td><td>01</td></tr>
<tr><td>Q. 2(a)</td><td>Explain why synchronous impedance method of computing the voltage regulation, leads to a pessimistic value while mmf method leads to optimistic value at lagging p.f. loads.</td><td>08</td><td>02</td><td>L-1</td><td>02</td></tr>
<tr><td>Q. 2(b)</td><td>A 6.6 kV, 3-phase, 50 Hz, star-connected alternator gave the following data for open circuit, short circuit and full-load zero-power factor tests:
<table>
<tr><td>I_f (A)</td><td>3.2</td><td>5.00</td><td>7.50</td><td>10.00</td><td>14.00</td></tr>
<tr><td>E_f (kV)</td><td>3.10</td><td>4.90</td><td>6.60</td><td>7.50</td><td>8.24</td></tr>
<tr><td>I_{sc} (A)</td><td>500</td><td>778</td><td>1170</td><td>---</td><td>---</td></tr>
<tr><td>Z.P.F. terminal voltage (kV)</td><td>-----</td><td>1.85</td><td>4.24</td><td>5.78</td><td>7.00</td></tr>
</table>
Per phase armature resistance is 0.2 Ω. Calculate the voltage regulation at full load current of 500 A at 0.8 p.f. lagging by ZPFC method.</td><td>12</td><td>02</td><td>L-1</td><td>02</td></tr>
</table>

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Q. 3(a)	Develop the excitation circles for a cylindrical rotor synchronous motor. How are these circles helpful in studying the steady state behavior of synchronous motor?	10	02	L-1	03
Q. 3(b)	A 3-phase star-connected alternator has synchronous impedance of 1+j10 Ω per phase. It is operating at a constant voltage of 6.6 kV and its field current is adjusted to give an excitation voltage of 6.4 kV. Find the power output, armature current and power factor under the conditions of maximum power input.	10	02	L-1	03
Q. 4(a)	Derive an expression for power developed in a cylindrical-rotor alternator in terms of power angle and synchronous impedance.	10	02	L-1	03
Q. 4(b)	A 400V, 3-phase mesh-connected synchronous motor runs at rated voltage and with an excitation emf of 510 V. Its synchronous impedance per phase is 0.5+j4 Ω and friction, windage and iron losses are 900 W. Calculate the shaft power output, line current, power factor and efficiency for maximum power output.	10	02	L-1	04
Q. 5(a)	What is the Blondel's two reaction theory of a salient pole machines? Hence draw and explain with voltage equations the salient pole synchronous generator phasor diagram and the salient pole synchronous motor phasor diagram for lagging p.f.	02+04 +04	02	L-1	05
Q. 5(b)	Explain the construction, principle of operation, types and applications of permanent magnet synchronous motor with diagram.	02+03 +04+01	02	L-1	07
Q. 6(a)	Explain the V-curves and inverted V-curves of a synchronous motor in detail. It is seen from the V-curve that for one value of armature current, there are two different values of field current. Out of these two field currents, which would give greater efficiency for a synchronous motor?	04+04 +02	03	L-1	05
Q. 6(b)	Explain the construction, principle of operation and applications of shaded pole motor.	10	03	L-1	06
Q. 7(a)	Write short notes on the following (1) Physical concept of hunting in a synchronous machine. (2) Concept of synchronizing power and synchronizing torque.	05 05	03	L-1	03
Q. 7(b)	Explain the construction, principle of operation, types and applications of stepper motor with diagram.	02+03 +04+01	03	L-1	07

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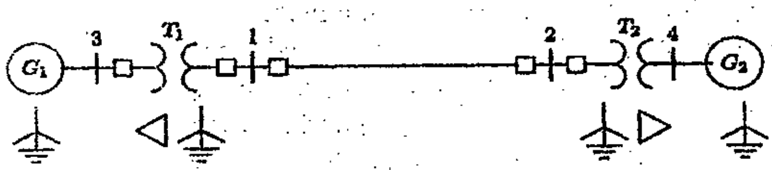
END SEM/RE-EXAM EXAMINATION DEC/JAN 2024-25

Program: B. Tech Electrical | **Duration: 3 hours**

Course Code: PC-BTE504 | **Maximum Points: 100**

Course Name: Power System Analysis | **Semester: V**

Notes: Question 1 is compulsory.

<table>
<tr><th>Q. No.</th><th>Questions</th><th>Points</th><th>CO</th><th>BL</th><th>Mo No.</th></tr>
<tr><td>1a</td><td>Applying equal area criteria, explain neatly, how can we obtain the maximum permissible rise in the power input to an alternator without losing the stability?</td><td>10</td><td>3</td><td>3,4</td><td>6</td></tr>
<tr><td>1b</td><td>Consider a single synchronous machine connected to infinite bus. If there is a small deviation $\Delta\delta$ from the initial machine angle δ_0, derive linearized swing equation which explains the dynamic behavior of the machine. What is synchronizing coefficient? How does it decide stability of the machine?</td><td>10</td><td>4</td><td>2,3</td><td>6</td></tr>
<tr><td>2</td><td>A power system with equipment ratings is as shown below. Find fault current for a Line to ground fault to be at bus 2. You can consider generator G1 or transformer T1 as a common base.


<table>
<tr><th>Equipment</th><th>kV</th><th>MVA</th><th>X_1 (p.u.)</th><th>X_2 (p.u.)</th><th>X_0 (p.u.)</th></tr>
<tr><td>G1</td><td>12.4</td><td>100</td><td>0.16</td><td>0.16</td><td>0.05</td></tr>
<tr><td>G2</td><td>13.2</td><td>90</td><td>0.2</td><td>0.2</td><td>0.05</td></tr>
<tr><td>T1</td><td>12/220</td><td>80</td><td>0.1</td><td>0.1</td><td>0.1</td></tr>
<tr><td>T2</td><td>220/12</td><td>80</td><td>0.1</td><td>0.1</td><td>0.1</td></tr>
<tr><td>Line</td><td></td><td></td><td>80 ohm</td><td>80 ohm</td><td>200 ohm</td></tr>
</table></td><td>20</td><td>1</td><td>2,3</td><td>1,2,3</td></tr>
<tr><td>3a</td><td>A 100 MVA, 11 kV three-phase alternator with solidly grounded neutral was subjected to different types of faults. The fault currents are as under: 3-phase fault = 2000 A; Line-to-Line fault = 2600 A ; Line-to-ground fault = 4200 A Find the values of the three sequence reactances of the alternator in ohm. Ignore resistances.</td><td>10</td><td>1</td><td>3,4</td><td>2,3</td></tr>
<tr><td>3b</td><td>Consider a 3-phase generator with Z_1, Z_2, & Z_0 as the positive, negative and zero sequence impedances and E_a is the generated emf, then assuming that generator is under no load before fault, prove that in case of a line to line fault, the fault current will be given as
$$I_f = -j\sqrt{3}\, I_a^1 = -j\sqrt{3}\,\frac{E_a}{Z_1 + Z_2}$$</td><td>10</td><td>1</td><td>1,2,3</td><td>2,3</td></tr>
</table>

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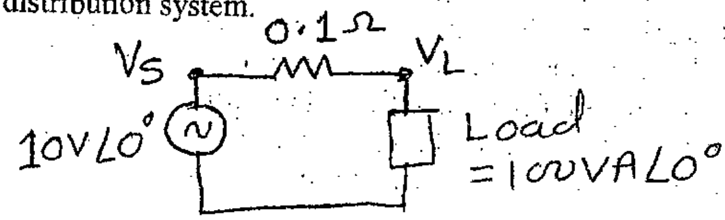
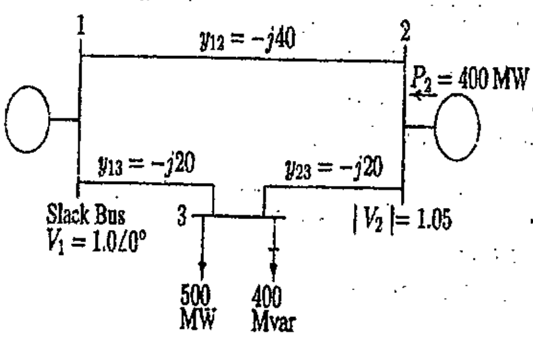
4a	Consider distributed model of transmission line and prove that for a overhead transmission line, velocity of propagation of voltage or current wave becomes approximately equal to velocity of light.	10	4	3,4	7
4b	Explain the advantages of per unit system. [4m] Prove that per unit impedance of a transformer referred to primary or secondary side remains the same. [6m]	10	1	1,2	1
5a	Explain the variation of current and voltage waves on an overhead line when one end of line is open-circuited and at the other end an ideal source of constant e.m.f. V is switched in. [6m] What are the reflection, refraction coefficient of current and voltage at the open circuited end?[4m]	10	4	3,4	7
5b	Explain with phasor diagram, the overvoltage that appears in healthy phases, when a L-G fault occurs at the one of the phases of an ungrounded alternator.	10	4	3,4	7
6a	Use backward forward sweep method to find the load currents as well as nodal voltages for following distribution system. 	10	2	3,5	3
6b	A generator operating at 60 Hz delivers 1 p.u. power to an infinite bus when a fault occurs which reduces the maximum power transferable to 0.4 p.u. The maximum power transferable before the fault was 1.75 p.u. and is 1.25 p.u. after the fault is cleared. Determine the critical clearing angle. If the inertia constant (H) of the generator is 4 p.u., determine the critical clearing time of the breakers. [5m] Draw the Power angle curve and show the accelerating, deaccelerating areas on the same for all three cases. [5m]	10	4	3,4	6
7	Figure shows a 3 bus system with line impedances marked in per unit on **50 MVA** base. Magnitude of generator bus voltage V_2 is fixed to 1.05 and slack bus V_1 is fixed to 1.0pu Assume initial value of V_3 =1+j0 and using Newton Raphson Method find magnitude of V_3 and angles of V_2,V_3 after 1 iteration.	20	2	3,5	



The bus admittance matrix in polar form is

$$Y_{bus} = \begin{bmatrix} 60\angle -\frac{\pi}{2} & 40\angle \frac{\pi}{2} & 20\angle \frac{\pi}{2} \\ 40\angle \frac{\pi}{2} & 60\angle -\frac{\pi}{2} & 20\angle \frac{\pi}{2} \\ 20\angle \frac{\pi}{2} & 20\angle \frac{\pi}{2} & 40\angle -\frac{\pi}{2} \end{bmatrix}$$

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End Sem / ~~Re-Exam~~ – December/~~January~~ 2024-~~25~~ Examinations

Program: Electrical

Course Code: PC-BTE505

Course Name: Communication Engineering

Duration: 3 hours

Maximum Points: 100

Semester: V

- Answer any **FIVE** out of SEVEN
- Make suitable assumptions wherever necessary

Q.No.	Questions	Points	CO	BL	Module No.
1a.	Discuss in detail the following type of modulations: i. DSB-FC ii. DSB-SC iii. SSB-SC iv. VSB v. ISB	10	1	2	1
1b.	Consider a telegraph source having two symbols dot and dash. The dot duration is 0.2 sec and the dash duration is 3 time of the dot duration. The probability of dot's occurrence is twice that of dash and the time between symbols is 0.2 sec. Calculate information rate of the telegraph source. Consider string of 1200 symbols.	10	2	3	5
2a..	Consider a systematic (7,4) cyclic code using generator polynomial $g(x) = x^3 + x^2 + 1$. Construct generator matrix for the same.	10	2	3	6
2b.	Draw the constellation diagram of (also known as signal space diagram) v. BPSK vi. QPSK vii. QAM viii. BASK	10	1	3	2

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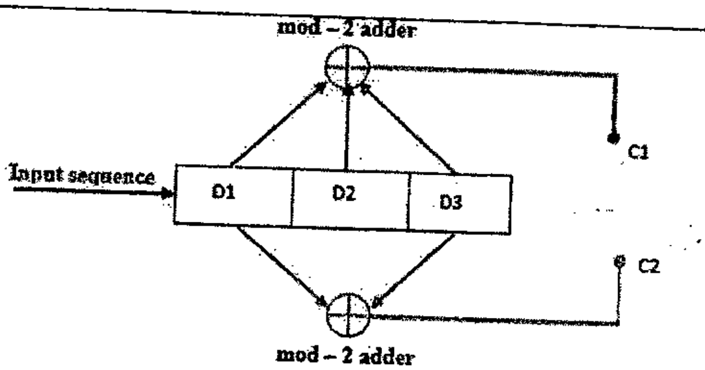
3a.	 For the given circuit construct the State diagram and Trellis Diagram.	10	2	3	6
3b.	Differentiate between i. Wideband FM and Narrowband FM ii. FM and PM	10	1	3	1
4a.	Discuss in detail Twisted ring cable and Fiber optic cables.	10	3	2	4
4b.	Discuss the Generation and Detection of PWM along with the waveforms.	10	1	2	3
5a.	Plot the QPSK waveforms for bit stream 0110100. Clearly show the waveforms of be(t), bo(t), Se(t), So(t) also.	10	1	2	2
5b.	Compare and Contrast different types of communication. (include simplex, half duplex and full duplex communications)	10	4	2	7
6a.	Differentiate between i. Peer to peer network and Client server network ii. PAN and LAN	10	4	3	7
6b.	Discuss in detail Super heterodyne Receiver	10	1	2	1
7a.	Discuss Shannon's Theorem on Capacity of a channel, Negative statement associated with the Shannon's theorem and Shannon – Hartley theorem on channel capacity.	10	2	2	5
7b.	Discuss Adaptive Delta modulation in detail along with waveforms	10	1	2	3

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END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: B.tech Electrical **Duration: 3 hours**

Course Code: PE-BTE501 **Maximum Points: 100**

Course Name: Design of Power Electronics Converters **Semester: V**

Notes:

Question no. 1 is compulsory

Solve any 4 questions for remaining 6 questions

Q.No.	Questions	Points	CO	BL	Module No.
Q1A)	Discuss the switching loss in a diode?	6	1	3	1
B)	What is electromagnetic compatibility?	6	3	3	7
C)	Discuss the requirement of snubbers in power electronics circuit.	8	2	3	4
2A)	For following Problems, note the given important instructions for writing answers: Write numerical answers up to two decimal places. For example: 3.00, 63.78 Apply rounding off. For example: enter 65.375 as 65.38 and 5.374 as 5.37 Solve all problems dependent on answers of previous steps, using values obtained after rounding off up to two decimal places in previous steps. For following problems you need to read the datasheet of MOSFET IRF530NPbF provided with paper. A buck converter is designed using MOSFETs (Manufacturer part no: IRF530NPbF). Following can be noted for the converter: Input Voltage: 40V Output Voltage: 20V Switching frequency(fs): 100 kHz Ambient temperature: 60°C Average inductor current: I_L:8A Assume switch current, Isw: 4 A 1. Find the typical turn ON time of MOSFET in nanoseconds. (2 marks)	12	2	3	5

	2. Find the typical turn OFF time of MOSFET in nanoseconds. (2 marks) 3. Find the MOSFET conduction loss in watts. (2 marks) 4. Find the MOSFET switching loss in watts. (2 marks) 5. Find the MOSFET total loss in watts. (1 mark) 6. Find the Sink to ambient resistance, $R_{\theta sa}$......(∘C /W) (1 mark) 7. Select the most appropriate heat sink for the design if natural cooling is performed from following and justify the selection: (2 marks) a) Manufacturer part no: FK 243 MI 247 O(18.7 ∘C/W) b) Manufacturer part no: ICK 14/16 L(46 ∘C/W) c) Manufacturer part no: 217-36CTE6(55 ∘C/W) d) Manufacturer part no: ICK SMD A 10 SA(75 ∘C/W)				
2 B)	Discuss the losses need to be considered while designing magnetic circuit in converter. Which parameters impact the losses?	8	2	3	6
3)	• **Write answers up to two decimal places. For example: 3.00, 63.78.** • **Apply rounding off. For example: enter 65.375 as 65.38 and 5.374 as 5.37.** • **Solve all problems dependent on answers of previous steps, using values obtained after rounding off up to two decimal places in previous steps.** • **Refer AWG data and ferrite core datasheet attached.** An inductor L = 50 μH need to be designed for a buck converter. The current rating of the inductor is chosen as 20 A and ripple limit is 0.5 A. Following specifications are chosen for the design: Bm = 0.2 T, Jm = 3 A/mm^2, Window fill factor Ku = 0.4 1. Find the area product Ap in cm^4. (3 marks) Let EE ferrite core is chosen to design the inductor. 2. Which among the following ferrite cores you'll choose for the design. And justify your selection. (2 marks) a) EE-187 b) EE-325 c) EE-21 d) EE-75 3. What is the window area, Wa of the core? Find answer in cm^2. (2 marks) 4. Find the cross-sectional area, AC of the core in cm^2. (1 mark) 5. Find the Magnetic path length of the core in cm. (1 mark) 6. Calculate $\mathbf{I_{Lrms}}$ ... (A). (2 marks) 7. Find the cross sectional area of conductor in mm^2. (2 marks) 8. Find the appropriate AWG to be chosen for the conductor and justify the	20	2	4	

	selection.(2 marks) 9. Calculate number of turns N for inductor. (2 marks) 10. If relative permeability is 2300, calculate air gap length, lg in mm. (3 marks)				
4A)	Discuss the steps involved in designing snubber using following points Circuit for which snubber is designed, E1, E, dv/dt, ξ, and χ.	14	2	3	4
4B)	Discuss the main reason/s for EMI in power electronic converter.	6	3	3	7
5)	Follow the instructions given in question no. 2 A buck converter is designed using two MOSFETs - IRFP90N20DPbF. 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 45 V. The value of parasitic inductance is estimated as L_p = 8 nH. 1. From the datasheet, the dv/dt limit for the body diode is obtained as ... V/ns. (1 mark) 2. Using the typical values of Q_{rr} and t_{rr} given in datasheet, the reverse recovery current I_{rr} is calculated as ... A. (2 marks) The power electronics engineer uses the following limits to design RC snubber for the body-diode: (a) Peak voltage limit, E1 = 2 X Input voltage (b) $(dv/dt)_{av}$ limit = half of dv/dt limit given in datasheet for body diode First, design the snubber by limiting the peak voltage 3. Find value of E1/E. (1 mark) Let the corresponding values of χ_0 = 2 and ζ_0 = 0.4 are obtained using the respective curves to design snubbers by this method 4. Find the value of C_s. ... (pF) (2 marks) 5. Find the value of R_s. ... (Ω) (2 marks)	20	2	4	3

	Second, design the snubber by limiting (dv/dt)av. Cs = 2 nF is chosen for the snubber. 6. Calculate $\frac{(\frac{dv}{dt})av}{E\times\omega_0}$ -----(4 marks) Let the corresponding values of $\chi_0 = 0.9$ and $\zeta_0 = 0.15$ are obtained using the respective curves to design snubbers by this method. 7. Find the value of R_s. … (Ω) (2 marks) Third, do a compromised design of the snubber for limiting both peak voltage and $(dv/dt)_{av}$. 8. Calculate $(dv/dt)_{av}$ .Lpl_{rr}/E_2. (2 marks) Let the corresponding values of $\chi_0 = 0.1$ and $\zeta0 = 0.9$ are obtained using the respective curves to design snubbers by this method. 9. Find the value of C_s. … (nF) (2 marks) 10. Find the value of R_s. … (Ω) (2 mark)				
Q6)	Mention the assumptions, conditions (1 mark), and derive the L_{cri}, **Ccri**, L_{ripple} of buck converter (6 marks). Draw voltage appearing across switch, diode, inductor, capacitor and load (6 marks). Draw load current, inductor current and capacitor current (5 marks). Mention the name of switch used and switching frequency used for it (2 marks).	20	1	3	1.2
Q7A)	For a certain application an UPS is designed. It contains an H bridge inverter as one of the main conversion stages inside. To obtain a sinusoidal voltage at the output of UPS, the output of the H bridge is connected to a low pass LC filter. Initially, the power electronic engineer designed the UPS using bipolar PWM. Later the engineer decided to change the modulation strategy to unipolar PWM. • Which of the following is/are true? (justify the answer) ➢ The design of UPS is unaffected. ➢ Switch voltage and current ratings will reduce. ➢ DC bus capacitor needs to be changed. ➢ Smaller values of L and C for the LC filter can be chosen.	10	1	4	1
Q7B)	**Compare bipolar and unipolar modulation techniques.**	**10**	**1**	**4**	**1**

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IRF530NPbF

HEXFET® Power MOSFET

- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
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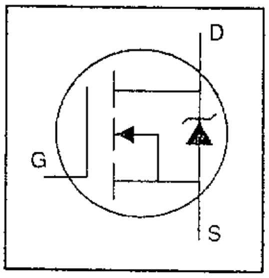


V_{DSS} = 100V

$R_{DS(on)}$ = 90mΩ

I_D = 17A

Description

Advanced HEXFET® Power MOSFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

TO-220AB

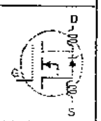
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	17	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	12	
I_{DM}	Pulsed Drain Current ①	60	
P_D @T_C = 25°C	Power Dissipation	70	W
	Linear Derating Factor	0.47	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
I_{AR}	Avalanche Current①	9.0	A
E_{AR}	Repetitive Avalanche Energy①	7.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	7.4	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 srew	10 lbf•in (1.1N•m)	

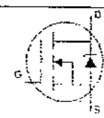
Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{θJC}$	Junction-to-Case	—	2.15	°C/W
$R_{θCS}$	Case-to-Sink, Flat, Greased Surface	0.50	—	
$R_{θJA}$	Junction-to-Ambient	—	62	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	100	—	—	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.11	—	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	90	mΩ	V_{GS} = 10V, I_D = 9.0A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
g_{fs}	Forward Transconductance	12	—	—	S	V_{DS} = 50V, I_D = 9.0A④
I_{DSS}	Drain-to-Source Leakage Current	—	—	25	μA	V_{DS} = 100V, V_{GS} = 0V
		—	—	250		V_{DS} = 80V, V_{GS} = 0V, T_J = 150°C
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	V_{GS} = 20V
	Gate-to-Source Reverse Leakage	—	—	-100		V_{GS} = -20V
Q_g	Total Gate Charge	—	—	37	nC	I_D = 9.0A
Q_{gs}	Gate-to-Source Charge	—	—	7.2		V_{DS} = 80V
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	—	11		V_{GS} = 10V, See Fig. 6 and 13
$t_{d(on)}$	Turn-On Delay Time	—	9.2	—	ns	V_{DD} = 50V
t_r	Rise Time	—	22	—		I_D = 9.0A
$t_{d(off)}$	Turn-Off Delay Time	—	35	—		R_G = 12Ω
t_f	Fall Time	—	25	—		V_{GS} = 10V, See Fig. 10 ④
L_D	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact 
L_S	Internal Source Inductance	—	7.5	—		
C_{iss}	Input Capacitance	—	920	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	130	—		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	—	19	—		f = 1.0MHz, See Fig. 5
E_{AS}	Single Pulse Avalanche Energy②	—	340⑤	93⑥	mJ	I_{AS} = 9.0A, L = 2.3mH

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	17	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode)①	—	—	60		
V_{SD}	Diode Forward Voltage	—	—	1.3	V	T_J = 25°C, I_S = 9.0A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	93	140	ns	T_J = 25°C, I_F = 9.0A
Q_{rr}	Reverse Recovery Charge	—	320	480	nC	di/dt = 100A/μs ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Notes:

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)

② Starting T_J = 25°C, L = 2.3mH R_G = 25Ω, I_{AS} = 9.0A, V_{GS}=10V (See Figure 12)

③ I_{SD} ≤ 9.0A, di/dt ≤ 410A/μs, V_{DD} ≤ $V_{(BR)DSS}$, T_J ≤ 175°C

④ Pulse width ≤ 400μs; duty cycle ≤ 2%.

⑤ This is a typical value at device destruction and represents operation outside rated limits.

⑥ This is a calculated value limited to T_J = 175°C .

American Wire Gauge Conductor Size Table

American wire gauge (AWG) is a standardized wire gauge system for the diameters of round, solid, nonferrous, electrically conducting wire. The larger the AWG number or wire guage, the smaller the physical size of the wire. The smallest AWG size is 40 and the largest is 0000 (4/0). AWG general rules of thumb - for every 6 gauge decrease, the wire diameter doubles and for every 3 gauge decrease, the cross sectional area doubles. **Note** - W&M Wire Gauge, US Steel Wire Gauge and Music Wire Gauge are different systems.

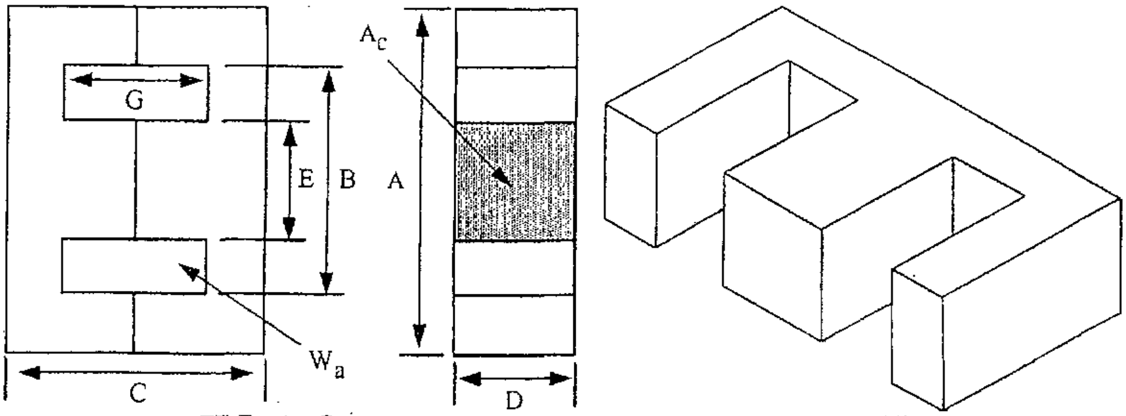
American Wire Gauge (AWG) Sizes and Properties Chart / Table

Table 1 lists the AWG sizes for electrical cables / conductors. In addition to wire size, the table provides values load (current) carrying capacity, resistance and skin effects. The resistances and skin depth noted are for copper conductors. A detailed description of each conductor property is described below Table 1.

AWG	Diameter [inches]	Diameter [mm]	Area [mm^2]	Resistance [Ohms / 1000 ft]	Resistance [Ohms / km]	Max Current [Amperes]	Max Frequency for 100% skin depth
0000 (4/0)	0.46	11.684	107	0.049	0.16072	302	125 Hz
000 (3/0)	0.4096	10.40384	85	0.0618	0.202704	239	160 Hz
00 (2/0)	0.3648	9.26592	67.4	0.0779	0.255512	190	200 Hz
0 (1/0)	0.3249	8.25246	53.5	0.0983	0.322424	150	250 Hz
1	0.2893	7.34822	42.4	0.1239	0.406392	119	325 Hz
2	0.2576	6.54304	33.6	0.1563	0.512664	94	410 Hz
3	0.2294	5.82676	26.7	0.197	0.64616	75	500 Hz
4	0.2043	5.18922	21.2	0.2485	0.81508	60	650 Hz
5	0.1819	4.62026	16.8	0.3133	1.027624	47	810 Hz
6	0.162	4.1148	13.3	0.3951	1.295928	37	1100 Hz
7	0.1443	3.66522	10.5	0.4982	1.634096	30	1300 Hz
8	0.1285	3.2639	8.37	0.6282	2.060496	24	1650 Hz
9	0.1144	2.90576	6.63	0.7921	2.598088	19	2050 Hz
10	0.1019	2.58826	5.26	0.9989	3.276392	15	2600 Hz
11	0.0907	2.30378	4.17	1.26	4.1328	12	3200 Hz
12	0.0808	2.05232	3.31	1.588	5.20864	9.3	4150 Hz
13	0.072	1.8288	2.62	2.003	6.56984	7.4	5300 Hz
14	0.0641	1.62814	2.08	2.525	8.282	5.9	6700 Hz
15	0.0571	1.45034	1.65	3.184	10.44352	4.7	8250 Hz
16	0.0508	1.29032	1.31	4.016	13.17248	3.7	11 k Hz
17	0.0453	1.15062	1.04	5.064	16.60992	2.9	13 k Hz
18	0.0403	1.02362	0.823	6.385	20.9428	2.3	17 kHz
19	0.0359	0.91186	0.653	8.051	26.40728	1.8	21 kHz
20	0.032	0.8128	0.518	10.15	33.292	1.5	27 kHz
21	0.0285	0.7239	0.41	12.8	41.984	1.2	33 kHz
22	0.0254	0.64516	0.326	16.14	52.9392	0.92	42 kHz
23	0.0226	0.57404	0.258	20.36	66.7808	0.729	53 kHz
24	0.0201	0.51054	0.205	25.67	84.1976	0.577	68 kHz
25	0.0179	0.45466	0.162	32.37	106.1736	0.457	85 kHz
26	0.0159	0.40386	0.129	40.81	133.8568	0.361	107 kHz
27	0.0142	0.36068	0.102	51.47	168.8216	0.288	130 kHz

Design and Dimensional Data for EE Ferrite Cores

The dimensional outline for EE ferrite cores is shown in Figure 3-30. Dimensional data for EE ferrite cores is given in Table 3-18; design data is given in Table 3-19.



EE Ferrite Cores   Perspective View

Figure 3-30. Dimension Outline for EE Ferrite Cores.

Table 3-18. Dimensional Data for EE Ferrite Cores.

EE, Ferrite Cores (Magnetics)													
Part No.	A cm	B cm	C cm	D cm	E cm	G cm	Part No.	A cm	B cm	C cm	D cm	E cm	G cm
EE-187	1.930	1.392	1.620	0.478	0.478	1.108	EE-21	4.087	2.832	3.300	1.252	1.252	2.080
EE-2425	2.515	1.880	1.906	0.653	0.610	1.250	EE-625	4.712	3.162	3.940	1.567	1.567	2.420
EE-375	3.454	2.527	2.820	0.935	0.932	1.930	EE-75	5.657	3.810	4.720	1.880	1.880	2.900

Table 3-19. Design Data for EE Ferrite Cores.

EE, Ferrite Cores (Magnetics)											
Part No.	W_{tcu} grams	W_{tfe} grams	MLT cm	MPL cm	$\frac{W_a}{A_c}$	A_c cm^2	W_a cm^2	A_p cm^4	K_g cm^5	A_t cm^2	*AL mh/1K
EE-187	6.8	4.4	3.8	4.01	2.219	0.228	0.506	0.116	0.0028	14.4	500
EE-2425	13.9	9.5	4.9	4.85	2.068	0.384	0.794	0.305	0.0095	23.5	767
EE-375	36.4	33.0	6.6	6.94	1.875	0.821	1.539	1.264	0.0624	45.3	1167
EE-21	47.3	57.0	8.1	7.75	1.103	1.490	1.643	2.448	0.1802	60.9	1967
EE-625	64.4	103.0	9.4	8.90	0.808	2.390	1.930	4.616	0.4700	81.8	2767
EE-75	111.1	179.0	11.2	10.70	0.826	3.390	2.799	9.487	1.1527	118.0	3467

*This AL value has been normalized for a permeability of 1K. For a close approximation of AL for other values of permeability, multiply this AL value by the new permeability in kilo-perm. If the new permeability is 2500, then use 2.5.

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END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: Electrical Engineering **Duration: 3 Hr**

Course Code: PE-BTE502 **Maximum Points: 100**

Course Name: Sensors and Actuators **Semester: V**

Notes:

- **Question 1 is compulsory.**
- **Attempt any 4 of remaining 6 questions.**
- Illustrate your answers with neat sketches wherever necessary.
- Assume appropriate data if required and state your reason.
- Preferably, write the answers in sequential order.

Q.No.	Questions	Points	CO	BL	Module No.
1	a. Describe the working principles of any two primary sensing elements used in measurement systems.	5	1	2	1
	b. What is thermal imaging? Explain how it is used for temperature measurement in industrial and medical applications.	5	2	2,3	2
	c. Discuss the principle of operation of a Doppler flow meter. In what situations is this method preferable for flow measurement?	5	2,3	2,3	3
	d. Explain the operating principle of a pH sensor. Discuss its applications in industrial and laboratory settings.	5	1,3	2,3	4
2	a. Explain the input-output configuration of instruments and measurement systems. How does this configuration impact system performance?	6	1,2	2,4	1
	b. Differentiate between active and passive transducers. Provide examples of applications where each type is preferred.	7	2,3	2,3	1
	c. Explain the working principle of a thermistor. How does it differ from an RTD in terms of temperature measurement?	7	1,2	2,4	2
3	a. Describe the working principle of a strain gauge. How is it used to measure motion or dimensional changes?	6	1,2	2,3	2

END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

	b.	Explain the working principle of an electromagnetic flow meter. What are its advantages and limitations in industrial flow measurement?	7	1,2	2,4	3
	c.	Compare the methods used for measuring water flow and blood flow. What unique challenges are associated with blood flow measurement?	7	2,3	4,5	3
4	a.	Compare and contrast the characteristics of pH sensors and blood-glucose sensors. What factors influence the choice of these sensors for specific applications?	7	2,3	4,5	4
	b.	Describe the working principle of a chemical sensor. How does it differ from a biosensor in terms of operation and application?	7	1,2	2,4	4
	c.	Define Microsystems and explain their significance in modern sensor technology. Provide examples of applications where Microsystems are used.	6	1	1,2	[illegible]
5	a.	Explain how a micro-accelerometer works. Discuss its applications in the automotive and consumer electronics industries.	7	2,3	2,3	5
	b.	Explain the working principle of a DC motor. Discuss its applications in industrial and domestic settings.	7	1,2	2,3	6
	c.	What is a sensor-less system? Explain its advantages and provide examples of its use in modern engineering applications.	6	1,2	2,3	5
6	a.	Compare and contrast AC motors and stepper motors in terms of their operation, control, and applications.	7	1,2	4,5	6
	b.	Describe the function of solenoids as electric actuators. How are they used in automation systems?	6	1,2	2,3	6
	c.	Discuss the applications of smart sensors in automatic robots and automobile engine controls. How do smart sensors enhance the performance of these systems?	7	2,3	3,4	[illegible]
7	a.	Select a case study from a process industry (e.g., power plant, chemical plant). Identify the key sensors used and justify their selection based on system requirements.	7	3	3,5	7
	b.	Discuss the application of smart sensors in an automation industry. How do they improve system performance and reliability?	7	1,3	2,3	7
	c.	Explain the role of sensors in process industries. Provide examples of key sensors used in the power industry and their functions.	6	1	2,3	7