Electrical & Electronics Engineering

Model Question Paper

For Undergraduate Program

The model question papers are suggestive blueprints. The primary aim of these question papers is to bring clarity about the process of connecting questions to performance indicators and hence to course outcomes. Further, these question papers demonstrate how bloom's taxonomy can be used to understand the quality of question papers and their effectiveness in assessing higher order abilities. The structure of question papers, number of questions, choices given, time given for examination etc., can vary based on the practices of the University or college.

Table of Contents

Course Name: Circuit Analysis

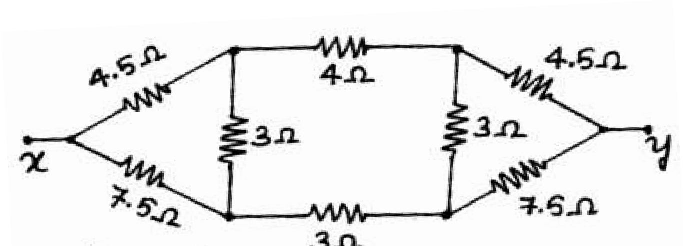
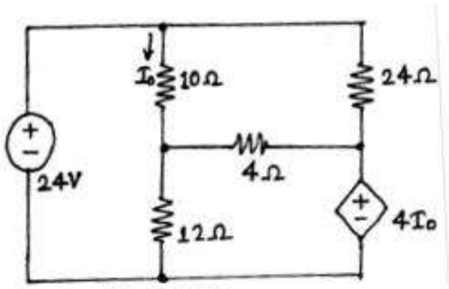
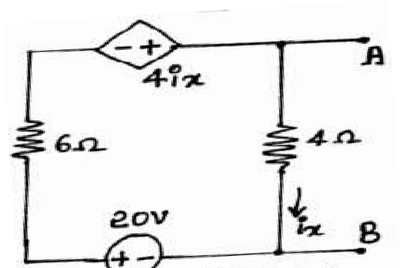
Course Outcomes (COs):

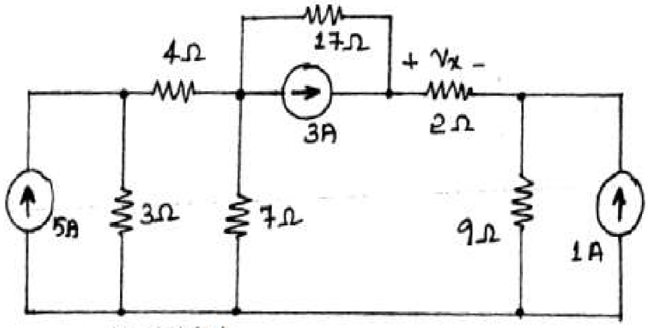
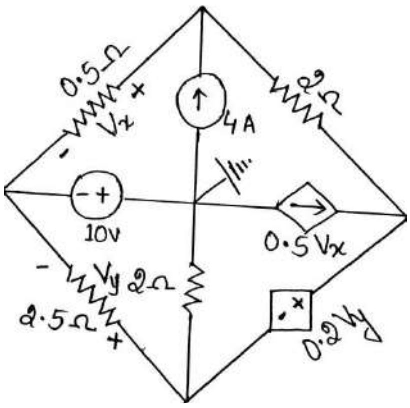
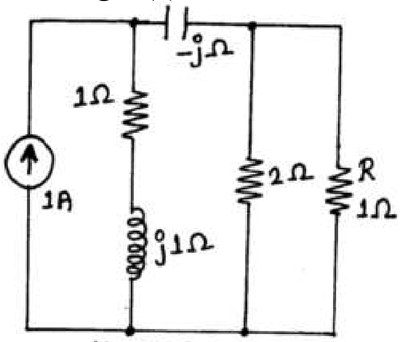
At the end of the course the student should be able to:

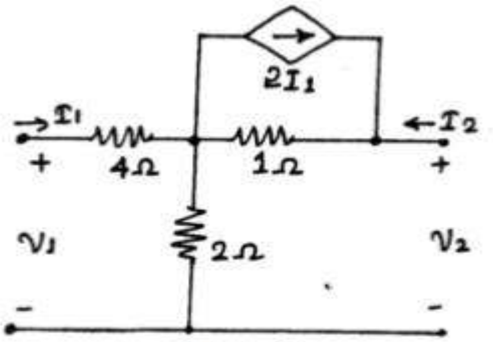
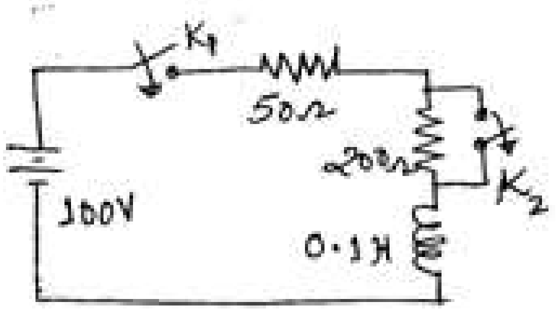
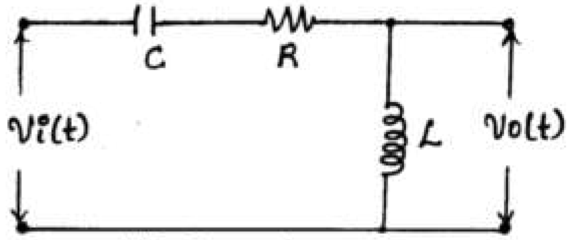
1. Analyze linear circuits using Nodal & Mesh Analysis
2. Apply Network theorems to both AC & DC circuits
3. Employ two port network models to represent active and passive networks
4. Analyze and determine the transient response, time domain and frequency domain behavior of First order circuits
5. Analyze and predict the time domain and frequency domain behavior of Higher order circuits
6. Analyze and draw phasor diagrams for single phase circuits
7. Analyze and draw phasor diagrams for three phase circuits
8. Utilize simulation tool (such as PSpice, Microcap) to accurately analyze circuits

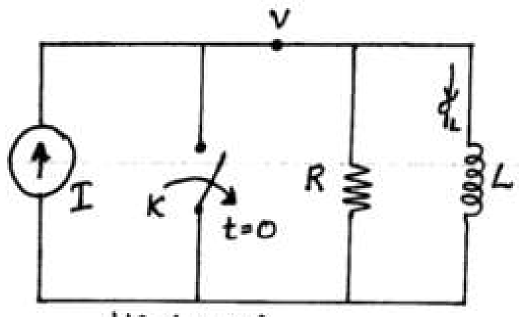
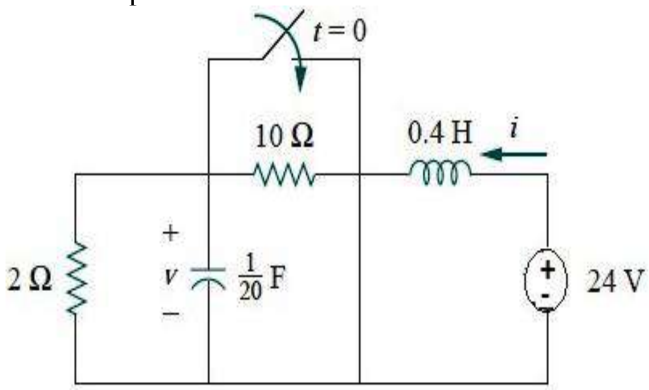
Model Question Paper

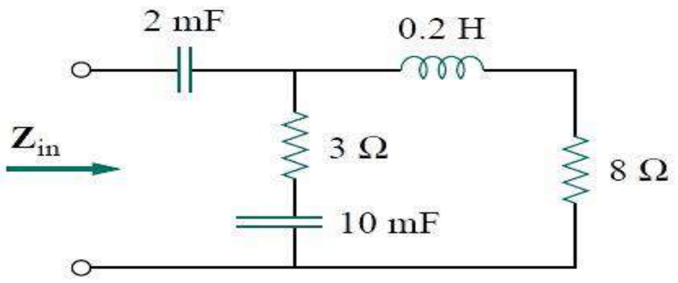
Course: Circuit Analysis

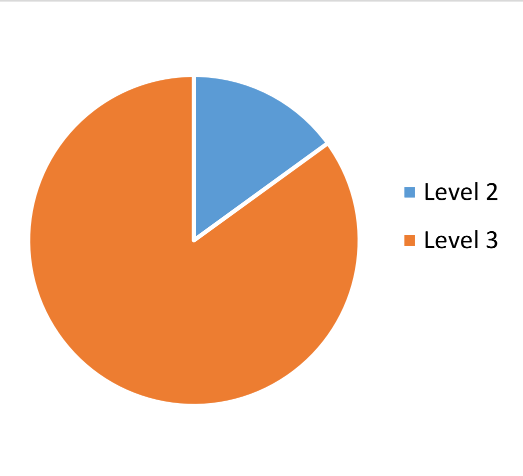
Q.No.	Questions	Marks	CO	BL	PI Code
1a	Use Y-Δ and Δ-Y transformation to find Rth between points xy. (fig.1.(a)).  fig (1) (a)	6	CO1	L3	1.4.1
1b	Apply Norton's theorem to find 'I_0' in the circuit given (fig.1.(b)).  fig (1) (b)	6	CO2	L3	1.4.1
1c	For the circuit (fig.1.(c)) given find, i. Thevenin's equivalent circuit at terminals A & B. ii. How much power would be delivered to a resistor connected to AB if R_{AB}=5Ω  fig (1) (c)	8	CO2	L3	1.4.1
2a	State and prove Maximum power transfer theorem for an AC circuit having impedance source & pure resistive load.	6	CO2	L2	1.4.1

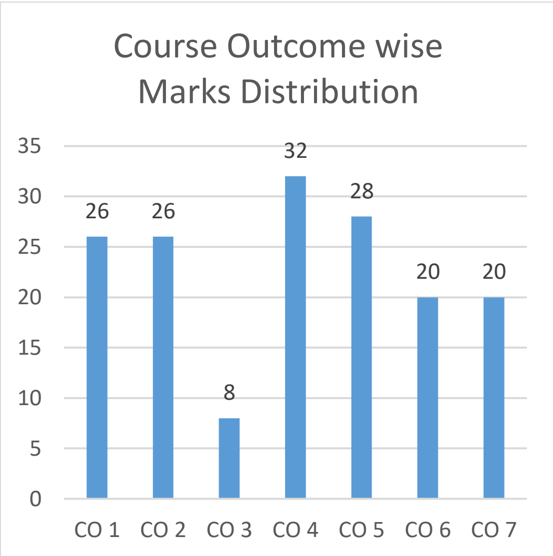
Q.No.	Questions	Marks	CO	BL	PI Code
2b	Determine the voltage 'Vx' across the 2Ω resistor using source transformation method (fig.2.(b)).  fig (2)(b).	6	CO1	L3	1.4.1
2c	Solve for Vx & Vy using the supernode concept for the circuit shown in Fig. 2(c).  	8	CO1	L3	1.4.1
3a	Demonstrate Reciprocity theorem for the voltage across R, for the network shown in fig.3.(a).  fig.(3)(a)	6	CO2	L3	1.4.1
3b	A very long string of 400 multicolored outdoor lights is installed on a house. After applying power, the home owner notices two bulbs are burnt out. i) Are the lights connected in series or parallel? ii) After replacing the burnt bulbs the owner notices that the lights closest to the supply are approximately 10% brighter than the lights at the far end of the string, provide	6	CO1	L3	2.1.3

Q.No.	Questions	Marks	CO	BL	PI Code
	a suitable explanation keeping in mind that nothing in the string is zero ohms. iii) Assuming 115V ac supply, individual bulb rating of 1Watt, determine the power supplied by the supply.				
3c	Find hybrid & ABCD parameters of the network shown in fig.3.(c)  fig (3) (c)	8	CO3	L3	1.4.1
4a	In the circuit of Fig 4(a), the switch K1 & K2 are closed at t = 0 secs and switch K2 is opened at t = 5 ms. Find the expression for the resulting value of the current. 	6	CO4	L3	1.4.1
4b	A unit pulse of width 'a' is applied to a RL series circuit. Determine the expression for the current. Given R = 1Ω and L = 1H.	6	CO4	L2	1.4.1
4c	For the circuit shown in fig.4.(c), derive the transfer function, find order of system, pole-zero location and frequency response.  fig (4) (c)	8	CO5	L3	1.4.1
5a	Refer the network shown in fig.5.(a), the switch 'k' is opens at t=0, at t=0+ solve for the values of 'v' & dv/dt, if I=2A, R=200Ω and L=1H.	6	CO4	L3	1.4.1

Q.No.	Questions	Marks	CO	BL	PI Code
	 fig (5)(a)				
5b	Explain Series resonance with characteristics and derive the relation between resonant and half power frequencies.	6	CO5	L2	1.4.1
5c	An a.c series circuit consisting of a coil connected in series with a capacitor and resister. The circuit draws a maximum current of 10A when connected to 200V, 50Hz supply. If the voltage across the capacitor is 500V at resonance,find the parameters R, L & C of the circuit and Quality factor.	8	CO4	L2	1.4.1
6a	Design a circuit to allow a room light to remain ‘ON’ for 5Sec after the switch has been turned ‘OFF’. Assume 40W bulb and 115 Ohm AC supply.	6	CO4	L3	2.1.3
6b	Derive the expression for dynamic resistance and resonant frequency in parallel resonant tank circuit.	6	CO5	L3	1.4.1
6c	The switch in Fig.6(c) was open for a long time but closed at t = 0. Determine expressions for i and v. 	8	CO5	L3	1.4.1
7a	A parallel RLC circuit comprising of a capacitor B_C=0.3S, inductor B_L=0.1S and a conductor of G=0.2S are connected to a current source of 10 amperes. Determine the branch currents and plot the complete phasor diagram.	10	CO6	L3	1.4.1
7b	Find the input impedance of the circuit in Fig.7(b). Assume that the circuit operates at ω = 50 rad/s.	10	CO6	L3	1.4.1

Q.No.	Questions	Marks	CO	BL	PI Code
					
8a	The impedance in each phase of a three phase 440v delta system comprises 5 ohms resistance in parallel with a 5 ohms capacitive reactance. Calculate the phase and line currents and the total power consumed .Draw the phasor diagram.	10	CO7	L3	1.4.1
8b	A three phase four wire system with line voltage of 400 v, 50 Hz supply has a star connected load of Z_R= 10 L0^0 ohms, Z_Y=15L30^0 ohms, Z_B=6-j5 ohms. Obtain the line currents and the current in the neutral conductor. Calculate the total power drawn. Draw the phasor diagram.	10	CO7	L3	1.4.1





BL – Bloom's Taxonomy Levels (1- Remembering, 2- Understanding, 3 – Applying, 4 – Analysing, 5 – Evaluating, 6 - Creating)
CO – Course Outcomes
PO – Program Outcomes; PI Code – Performance Indicator Code

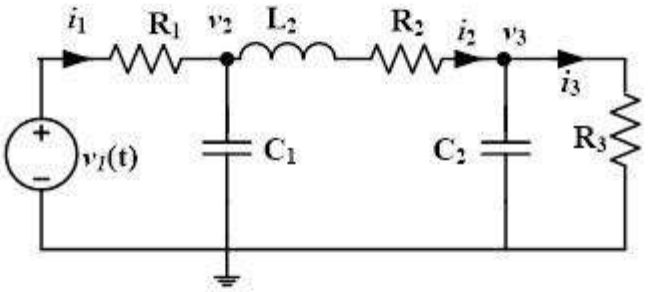
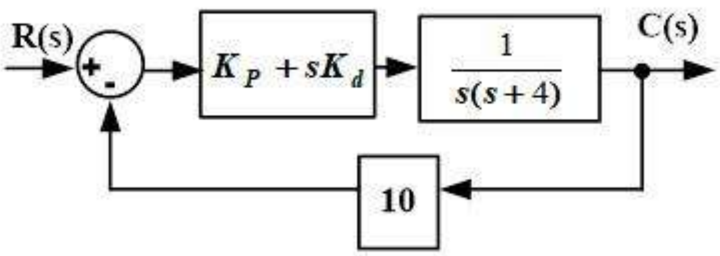
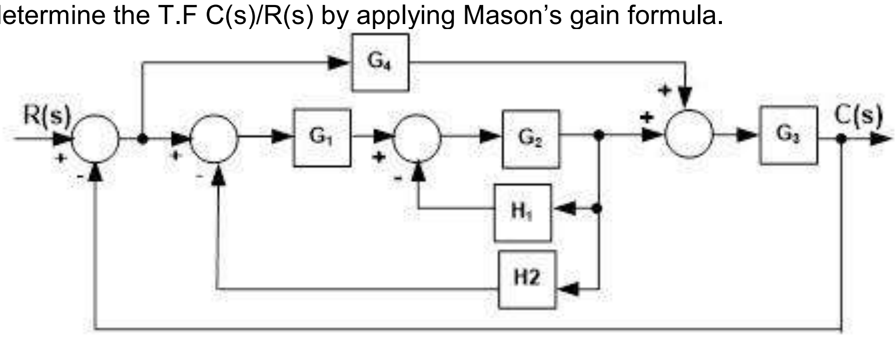
Course Name: Linear Control Systems

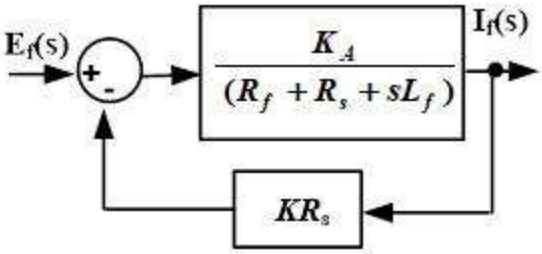
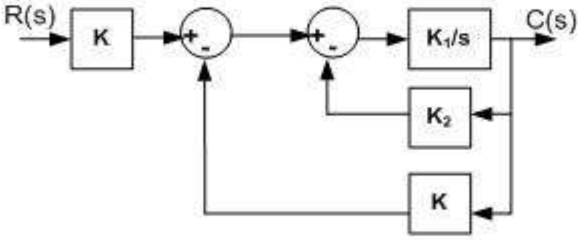
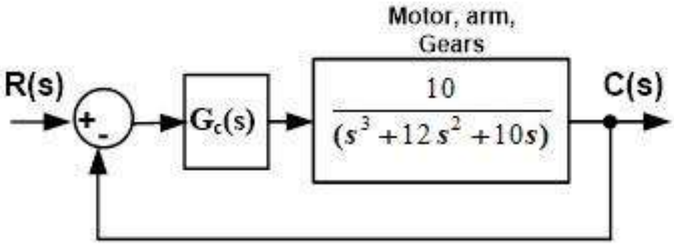
Course Outcomes (CO):

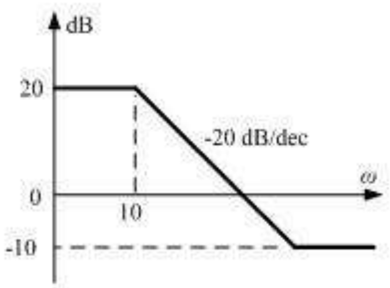
At the end of the course the student is able to:

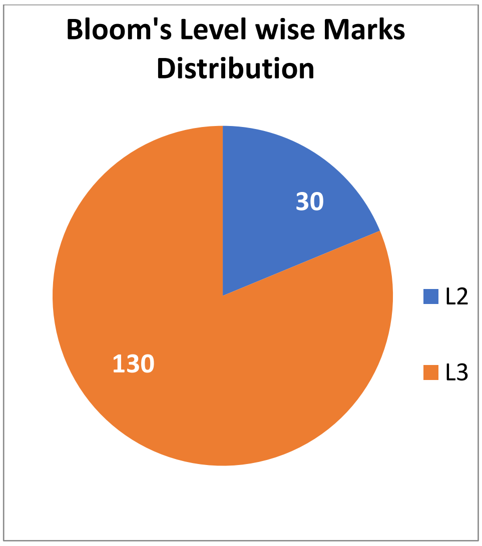
1. Develop the transfer function and block diagram/signal flow graph model of electrical/ electronic /electro-mechanical systems.
2. Analyze the control system performance using time-domain approach and validate through simulations.
3. Analyze the absolute/related stability of a given control system by employing Routh-Hurwitz criterion.
4. Design PI/PD/PID controllers for a given plant by Zeigler-Nichol's and Pole placement techniques.
5. Apply known techniques to reshape the frequency response of a given control system in the form of polar plot/Bode plot, determine response specifications and validate through simulations.
6. Apply known techniques to obtain root locus of a given control system to determine the response specifications as function of given control parameter and validate through simulations.

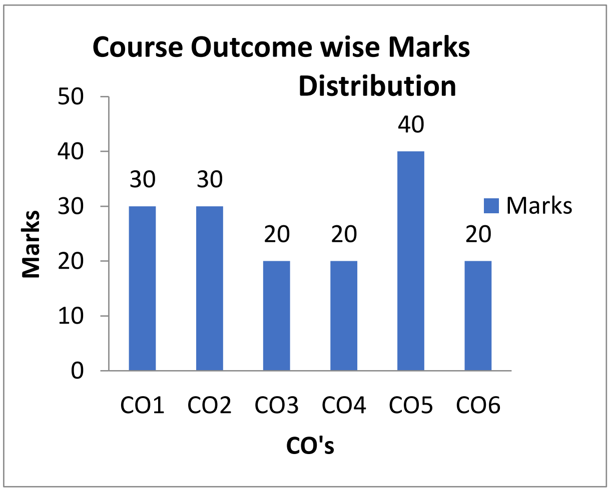
Model Question Paper
Course : Linear Control Systems

Q.No.	Questions	Marks	CO	BL	PO	PI Code
1a	For the electrical circuit of Fig., deduce the model equations and hence represent by signal-flow graph with v1 (input), v2, v3, i1, i2 and i3 (output) as variables.  	10	CO1	L3	13	13.1.1
1b	In industrial manufacturing certain robot arm is required to control the position of the end piece. Fig.1b shows the model of a closed loop position control system where the controller gains kp and kd are to be determined so as to satisfy the following specifications (i) Closed loop poles placed at (-3.6 ±β) (ii) Peak-time=0.65 sec. From the above descriptions (i) Identify the design specifications in terms of damping ratio (ζ) and angular frequency (ωn)(ii)Deduce relations for Kp and Kd in terms of ζ and ωn (iii) required gain settings (iv) Peak overshoot and settling time for these settings.  	10	CO2	L3	2	2.1.2
2a	Assuming under-damped unit step response of a second order control system, deduce expressions for peak-time and rise time. For a negative feedback control system, G(s)= (10s+72)/s(2s+6) and H(s)=1. Determine the peak overshoot, settling time and static error constants Kp, Kv and Ka.	10	CO2	L3	13	13.1.1
2b	For the block-diagram shown in Fig., obtain the signal flow graph and determine the T.F C(s)/R(s) by applying Mason's gain formula.  	10	CO1	L3	13	13.1.1
3a	First order field circuit model of a DC Generator is shown below where, Rf=50, Rs=1 and Lf=2.0. (i) If K=0.2, obtain an expression for unit step output response by selecting gain KA for zero steady-state error. (ii) If gain KA is varied from 80 to 120 in steps of 10, determine the values of gain K that give time constant ≤ 0.005 sec and plot in the parameter plane (KA, K) marking different regions of time constants. Also compute the corresponding steady-state error for unit step input and analyze the effect of KA variations on it.	10	CO1	L3	13	13.1.1

Q.No.	Questions	Marks	CO	BL	PO	PI Code
						
3b	The depth control system of a submersible vehicle is shown in fig. below, where K=0.5 (i) If K2=0.5 and gain K1 has limits 5 ≤ K1 ≤ 20, obtain the unit step response with K1 selected for fasted response.(ii) If gain K1 is varied from 1.0 to 7.0 in steps of 1.0, determine the gain K2 values that give time constant ≤ 0.1 and plot in the parameter plane K1 - K2. Also compute the corresponding equivalent gain (Ke) and steady-state errors and comment on the effect of K1 variations on the steady-state error. 	10	CO2	L2	13	13.1.1
4a	All elements in a row of Routh array are zero. What this indicates? How to overcome this situation? For a negative feedback control system, G(s)=(K-2)/s(s^2+s+1) and H(s)=1/(s+5). By applying RH criterion, determine the range of gain K over which the closed loop system is absolutely stable. Also investigate the stability and number of roots in RHS of s-plane when K=10 and K=0.5.	10	CO3	L3	13	13.1.1
4b	For a simplified model of DC generator voltage control system, Gp(s)=1/(1+s)(2+s) and H(s)=1 . Design PID controller assuming Ki=0.1 so as to place two dominant closed loop poles at (-3±j4).	10	CO4	L3	3	3.2.2
5a	The open loop T.F of a control system is G(s)H(s)=10/s(s+1)(s+5) . Sketch the approximate polar plot and analytically determine the gain margin.	10	CO5	L2	13	13.1.1
5b	Figure shows the model of the control system for one joint of a robot arm. The controller is a PD given as. Now it is required to determine the combinational values of Kp and Kd (both positive) for which the closed loop system is absolutely stable. In this respect (i) By applying RH criterion, deduce an expression for limiting value of Kd as a function of Kp (ii) If Kp is varied, determine the corresponding limiting value of Kd and plot in the parameter plane (Kp, Kd) marking stable and unstable regions. 	10	CO3	L3	2	2.4.1
6a	The open loop T.F of a control system is G(s)H(s)=10/s(1+2s). Obtain the approximate polar plot and analytically determine the phase margin	10	CO5	L3	13	13.1.1

Q.No.	Questions	Marks	CO	BL	PO	PI Code
6b	For a simplified model of a synchronous generator excitation control system, Gp(s)=0.8/(1+3s)(1+30s) and H(s)=1/(1+10s). Design PI and PID controllers using Zeigler-Nichol's tuning approach. Determine ultimate gain and time period using RH criterion	10	CO4	L3	3	3.2.2
7a	Briefly explain the procedure to compute gain and phase margins from Bode plot. For the Bode magnitude plot shown, determine Transfer function and  phase margin.	10	CO5	L3	13	13.1.1
7b	Sketch the asymptotic Bode magnitude plot and phase plot for the open loop transfer function G(s)H(s)=(1+2s)(1+0.1s)/s(s+0.5s)	10	CO5	L3	13	13.1.1
8a	Briefly explain the angle criterion of root locus technique. With an example, list the rules to construct the root locus diagram.	10	CO6	L2	13	13.1.1
8b	Show that the complex part of the root locus of G(s)H(s)=K(s+2)/(s^2+2s+3) is a circle	10	CO6	L3	13	13.1.1





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CO – Course Outcomes
PO – Program Outcomes; PI Code – Performance Indicator Code

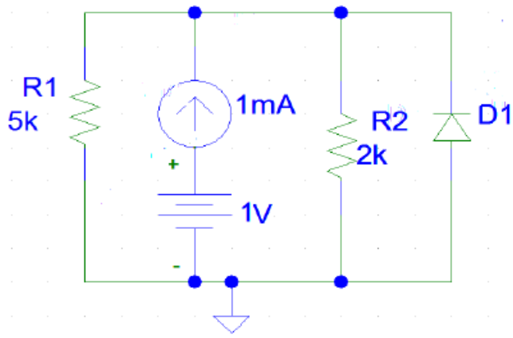
Course: Analog Electronics Circuits

Course Outcomes (COs):

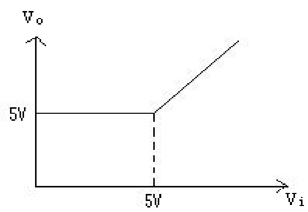
1. Infer the terminal behavior of the devices such as Junction Diode, BJT & MOSFET, also identify the region of operation with its equivalent circuit model.
2. Identify the need for small signal operation and derive the small signal performance parameters of the device for amplification by relating design variable to the device parameters.
3. Outline and parse the performance parameters of various feedback topologies & large signal amplifiers.

Model question paper for Analog Electronics Circuits

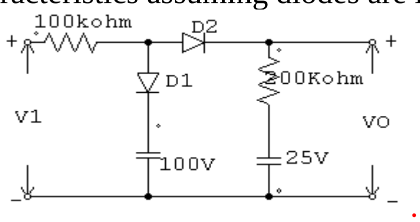
<table>
<tr><th>Q.No.</th><th>Questions</th><th>Marks</th><th>CO</th><th>BL</th><th>PO</th><th>PI</th></tr>
<tr><td>1a</td><td>The input waveform available is a square waveform of amplitude 5V and frequency 1kHz. Using appropriate diode circuit, modify the amplitude of the waveform suitably retaining same value of frequency. Use this waveform to trigger a digital circuit. Justify your answer.</td><td>7</td><td>CO1</td><td>L3</td><td>2</td><td>2.1.2</td></tr>
<tr><td>1b</td><td>Design a voltage divider bias BJT circuit to have V_{CE} = V_E = 5V and I_c= 5mA, when the supply voltage is 15V. Assume transistor h_{FE} = 100.</td><td>7</td><td>CO1</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
<tr><td>1c</td><td>The circuit given below consists of a non-linear diode. Determine V_B (voltage across 5kΩ) using small signal model of diode.



</td><td>6</td><td>CO1</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
<tr><td>2a</td><td>Design an appropriate diode circuit for the transfer function given below. Analyze the circuit and draw input output waveforms.



</td><td>7</td><td>CO1</td><td>L3</td><td>3</td><td>3.4.1</td></tr>
<tr><td>2b</td><td>The input voltage $v_i(t)$to the two level clipper shown in Fig.2a varies linearly from 0 to 150 V. Sketch the transfer characteristics assuming diodes are ideal



</td><td>7</td><td>CO2</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
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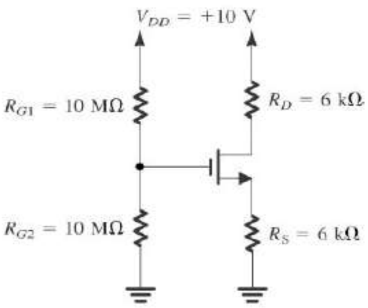
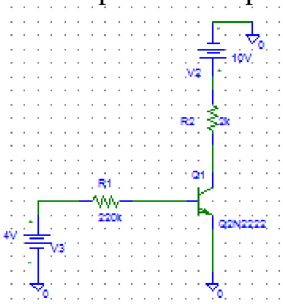
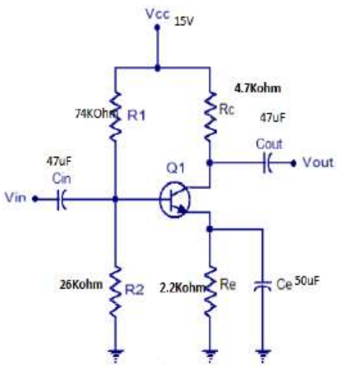
<tr><td>2c</td><td>Determine voltages at all nodes and the currents through all branches. Let $V_t = 1V$ and $k_n' \left(\frac{W_n}{L_n}\right) = 1mA/V^2$. Neglect channel length modulation.

</td><td>6</td><td>CO1</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
<tr><td>3a</td><td>Calculate the base, collector and emitter currents and V_{CE} for a common emitter circuit given below. Also determine the transistor power dissipation.

</td><td>7</td><td>CO1</td><td>L2</td><td>1</td><td>1.4.1</td></tr>
<tr><td>3b</td><td>Draw input and output characteristics of nMOS for increasing value of length and oxide thickness.</td><td>6</td><td>CO1</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
<tr><td>3c</td><td>Determine Zi, Zo, Av and Q(V_{CEQ} , I_{CQ}) of the circuit given below. Assume $h_{fe} = 180$, $h_{ie} = 2.7k\Omega$ and $h_{oe} = 25\mu mho$

</td><td>7</td><td>CO2</td><td>L2</td><td>1</td><td>1.4.1</td></tr>
<tr><td>4a</td><td>For the circuit given below, find the labelled node voltages. The nMOS transistors have $V_t = 1V$ and $k_n' \left(\frac{W_n}{L_n}\right) = 2mA/V^2$. Neglect channel length modulation.</td><td>6</td><td>CO1</td><td>L3</td><td>1</td><td>1.4.1</td></tr>
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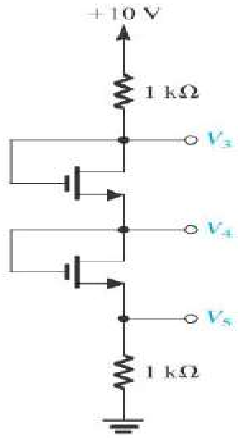
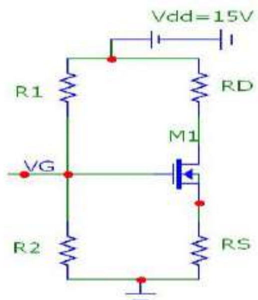
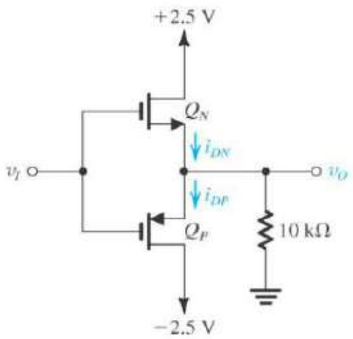
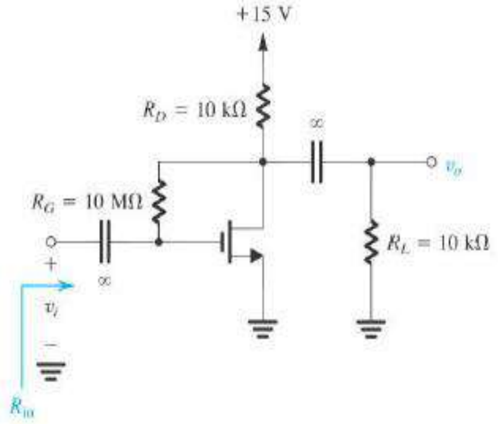
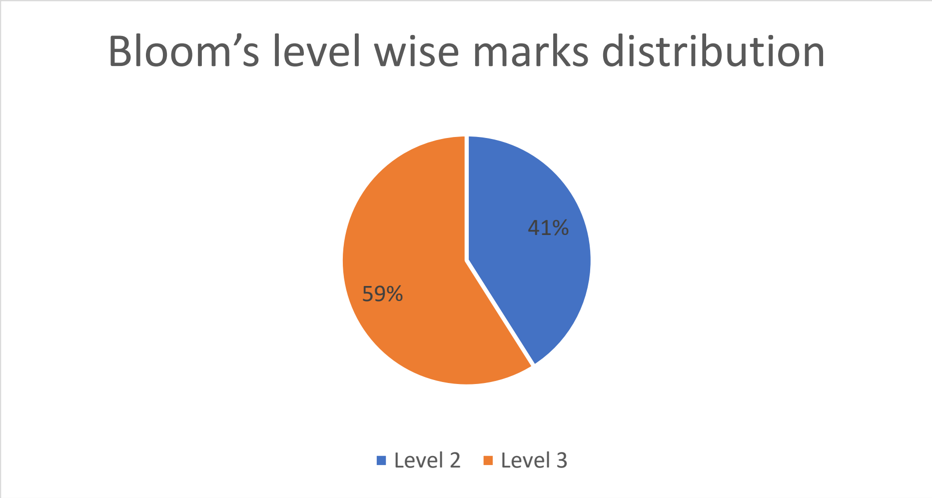
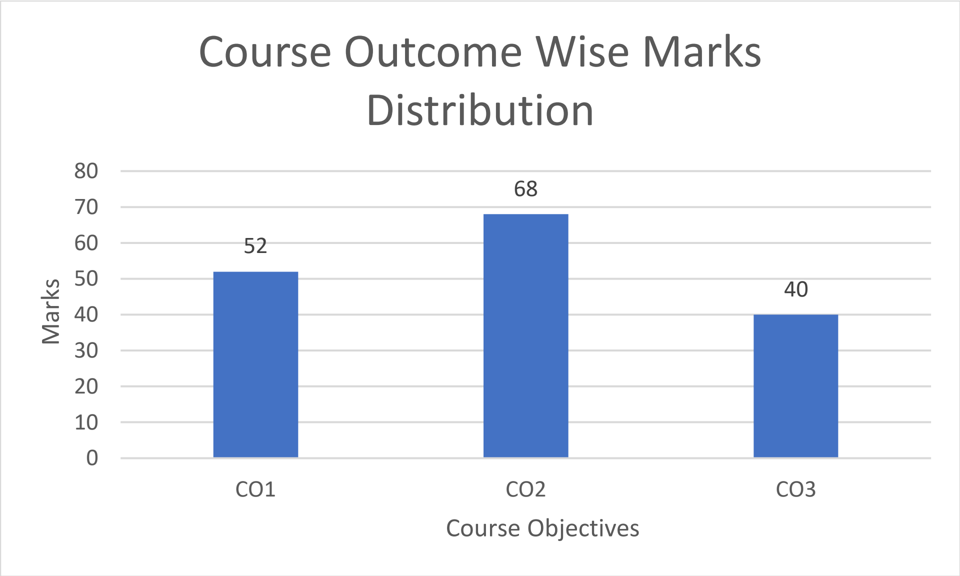
						
4b	For a CD amplifier, find the expression for $R_i, A_{vo}, A_v, R_{out}$ highlighting the effect of r_0 .	6	CO2	L3	1	1.4.1
4c	Design the circuit shown below to establish a dc drain current of 0.5mA. The MOSFET is specified to have $V_t = 1V$ and $k_n'\left(\frac{W_n}{L_n}\right)$=1mA/V^2 .For simplicity neglect the channel length modulation. $V_{DD} = 15V$ calculate the percentage change in the value of Id obtained when the MOSFET is replaced with having same $k_n'\left(\frac{W_n}{L_n}\right)$ but $V_t = 1.5V$ 	8	CO2	L3	3	3.4.1
5a	The NMOS and PMOS transistor in the circuit shown below are matched with $k_n'\left(\frac{W_n}{L_n}\right) = k_p'\left(\frac{W_p}{L_p}\right) = 1\,mA/V^2$ and $V_{tn} = -V_{tp} = 1V$. Assuming $\lambda = 0$ for both the devices. Find the drain currents and $i_{DN} i_{DP}$as well as voltage $v_o$for i)$v_I = 0V$ ii) $v_I = -2.5V$iii) $v_I = +2.5V$ 	10	CO2	L3	1	1.4.1
5b	A student is assigned a task to design an amplifier circuit to amplify an audio signal. The circuit chosen by	10	CO2	L3	2	2.1.2

	the student is given below. Identify the type of biasing circuit used. Determine its small signal voltage gain, input resistance and the largest allowable input signal. The transistor has $V_t = 1.5V$, $k_n'\left(\frac{W_n}{L_n}\right) = 0.25\, mA/V^2$, $V_A = 50V$. State the assumptions. 					
6a	Using two transistors Q1 and Q2 having equal lengths but different widths related by $W_2/W_1 = 5$. Design the circuit of basic current mirror to obtain I=0.5mA. Let $V_{DD} = 5V$, $K_n(W/L)_1 = 0.8mA/V^2$, $V_t = 1.5V$ and $\lambda=0$. Find the required value of R? What is voltage at the gates of Q1 and Q2? What is the lowest voltage allowed at the drain of Q2 while Q2 remains in the saturation region?	7	CO2	L2	1	1.4.1
6b	Draw the small signal model for common gate amplifier and derive the expression for input, output impedance and voltage gain.	7	CO2	L2	1	1.4.1
6c	An NMOS transistor has $\mu_n c_{ox} = 60\mu A/V^2$, $\frac{W}{L} = 40$, $V_t = 1.5V$ and $V_A = 15V$ (a) find g_m and r_0 when V_{GS}=1.5v (b) find g_m and r_0 when I_D=0.5mA	6	CO2	L2	1	1.4.1
7a	An amplifier with negative feedback has a voltage gain of 120. It is found that without feedback, an input signal of 60mV is required to produce a particular output. Find the Av and β of the amplifier.	6	CO3	L2	1	1.4.1
7b	Discuss the general characteristics of a negative feedback amplifier.	6	CO3	L2	1	1.4.1
7c	Derive an expression for input and output resistance of a voltage shunt feedback amplifier, and explain.	8	CO3	L2	1	1.4.1
8a	Explain the classification of power amplifiers based on the location of the operating point with neat diagrams.	6	CO3	L2	1	1.4.1
8b	Explain the operation of transformer coupled amplifier with neat circuit diagram and derive the expressions for maximum efficiency	6	CO3	L2	1	1.4.1

8c	A class B power amplifier is delivering an output voltage of 10 volts peak to an 8 Ω load, if the DC power supply is 30 volts; calculate i) DC power input. ii) AC power delivered to the load iii) Conversion efficiency iv) Power dissipated in the collector of each transistor.	8	CO3	L3	1	1.4.1



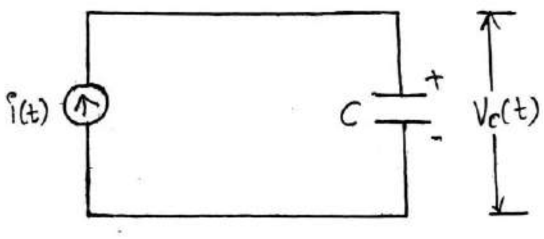


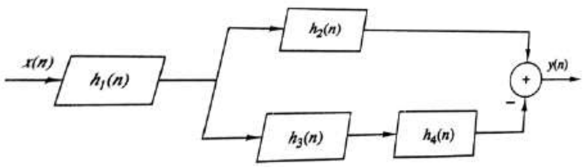
Course: Digital Signal Processing

Course Learning Objectives:

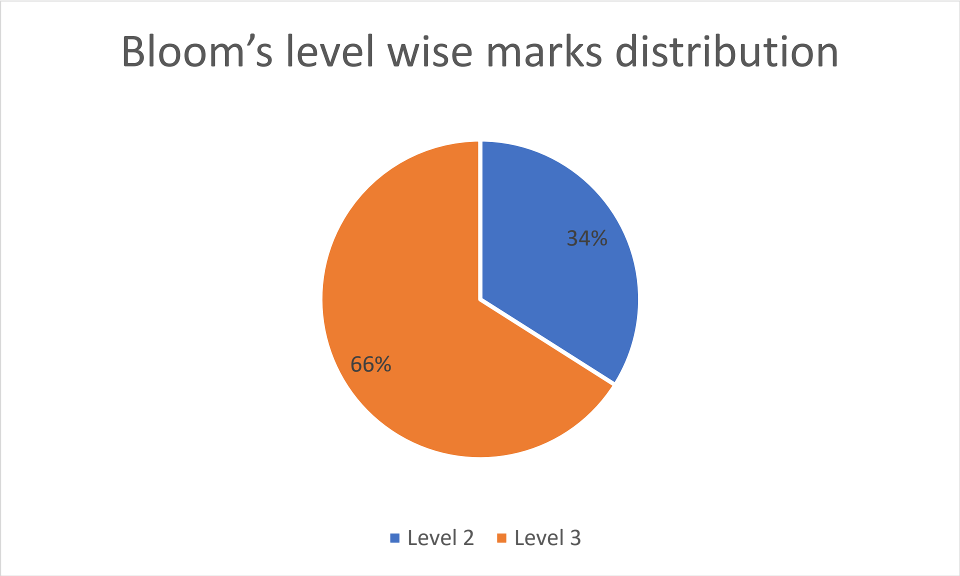
1. Represent the given signal mathematically, and apply it for system analysis
2. Represent LTI systems using differential and difference equations and hence analyze the same
3. Characterize the discrete time signal in frequency domain using Fourier series and Fourier transform
4. Apply DFT techniques for applications like spectral analysis, linear filtering.
5. Apply FFT techniques for applications like, linear filtering and Correlation.
6. Design digital IIR and FIR filters for the given specification
7. Explore the basic concepts of Signals and Systems, and Digital Signal Processing using computational tool.

Model question paper for Digital Signal Processing

Q.No.	Questions	Marks	CO	BL	PI Code
1a	Let $x(t)$ be a continuous time signal, and let $y_1(t) = x(2t)$ and $y_2(t) = x(t/2)$ .The signal $y_1(t)$ represents a speeded up version of $x(t)$ similarly $y_2(t)$ represents a slowed down version of $x(t)$. Consider the following statements i) If $x(t)$ is periodic , then $y_1(t)$ is periodic ii) If $y_2(t)$ is periodic , then $x(t)$ is periodic For each of these statements, determine whether it is true, and if so, determine the relationship between the fundamental periods of the two signals considered in the statement. If the statement is not true, produce a counterexample to it.	8	CO1	L3	1.4.1
1b	Consider the capacitor circuit shown in fig below. Let input $x(t) = i(t)$ and output $y(t) = v_c(t)$ i) Find the input-output relationship ii) Determine the system is a) memory less, b)Causal c)Linear d) Stable e) Time-invariant. 	6	CO2	L3	1.4.1
1c	Obtain the direct form-I, direct form-II for the following system which is represented in difference equation form. $y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2)$	6	CO2	L2	1.4.1
2a	Classify the following signals according to whether they are (1) one or multi-dimensional (2) continuous time or discrete time and (3) analog or digital (amplitude). Justify i) Closing prices of utility stocks on New York Stock Exchange	8	CO1	L3	1.4.1

Q.No.	Questions	Marks	CO	BL	PI Code
	ii) A color movie iii) Position of the steering wheel of a car in motion relative to car's reference frame.				
2b	Consider the interconnection of LTI system shown in fig below, i)Express overall impulse response in terms of $h_1(n), h_2(n), h_3(n)$ and $h_4(n)$with all intermediate steps  ii) Determine $h(n)$when $h_1(n) = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{2}\right\}$; $h_2(n) = h_3(n) = (n+1)u(n); h_4(n) = \delta(n-2)$	6	CO2	L3	1.4.1
2c	Sketch and label the following signals. i)$x(t) = -u(t+3) + 2u(t+1) - 2u(t-1) + u(t-3)$ ii)$y(t) = r(t+2) - r(t+1) - r(t-1) + r(t-2)$	6	CO1	L2	1.4.1
3a	An audio signal s(t) generated by a loud speaker is reflected at two different walls with reflection coefficients r_1, r_2. The signal $x(t)$ recorded by a microphone close to the loud speaker, after sampling, is $x(n) = s(n) + r_1 s(n-k_1) + r_2 s(n-k_2)$. Where k_1 and k_2 are the delays of two echoes. Determine autocorrelation $r_{xx}(l)$ of the signal $x(n)$.	8	CO2	L3	2.1.3
3b	Determine the total solution $y(n), n \geq 0$to the difference equation $y(n) + a_1 y(n-1) = x(n)$when $x(n)$is a unit step sequence and $y(-1)$is initial condition.	6	CO2	L2	1.4.1
3c	Show that any signal can be decomposed into an even and an odd component. Is the decomposition is unique? Illustrate your arguments using the signal $x(n) = \{2,3,\underline{4},5,6\}$	6	CO1	L2	1.4.1
4a	Given sequences $x_1[n] = \{1,1,2,1\} x_2[n] = \{1,2,3,4\}$ find $x_3[n]$such that $X_3(k) = X_1(k)X_2(k)$using DFT and IDFT method.	10	CO4	L2	1.4.1
4b	For an instance digital audio has long input data sequence $x[n] = \{1,2,-1,2,3,-2,-3,-1,1,1,2,-1\}$and $h[n] = \{1,2\}$ which are running at a rate of 5Mbytes /min. With this high data rate, it is common for computers to have insufficient memory to simultaneously hold the entire signal to be processed. Suggest a method to process the data segment by segment so that computers with insufficient memory can also handle the long data sequence which are running at high speed.	10	CO4	L3	2.1.3

Q.No.	Questions	Marks	CO	BL	PI Code
5a	Determine Fourier series co-efficients of a periodic signal $x[n] = \{1,1,0,0\}$with period N=4 also plot its magnitude and phase spectrum.	6	CO3	L2	1.4.1
5b	Compute circular convolution of the sequences $x[n] = \{1,2,3,1\}$ and $h[n] = \{4,3,2,2\}$ such that it is equivalent to linear convolution of the of the same sequences.	10	CO3	L3	1.4.1
5c	Find the Fourier Transform of $x(n) = \frac{1}{2}^{(n-1)}$. If you have used any property while determining $X(k)$, state it.	4	CO3	L2	1.4.1
6a	Compute IDFT of sequence $X[k] = \{7, -0.707 - j0.707, -j, 0.707 - j0.707, 1, 0.707 + j0.707, j, -0.707 + j0.707\}$using Radix-2 decimation in frequency FFT algorithm. Keep track of all intermediate results and show them on butterfly diagram.	10	CO5	L3	1.4.1
6b	The impulse response of an LTI system is given by $h(n) = \delta(n) - \frac{1}{4}\delta(n - k_0)$. To determine the impulse response $g(n)$ of the inverse system, an engineer computes the N-point DFT, $N = 4k_0$, of $h(n)$ and then defines $g(n)$ as the inverse DFT of $G(k) = \frac{1}{H(k)}, k = 0,1,2 \dots, N-1$. Determine $g(n)$ and the convolution$h(n) * g(n)$, and comment on whether the system with impulse response $g(n)$ is the inverse of the system with impulse response $h(n)$.	10	CO4	L3	1.4.1
7a	Convert the analog filter whose transfer function is given by $H(s) = \frac{2}{(s+1)(s+2)}$ to digital filter using impulse invariance method. Assume T=1 sec	10	CO6	L2	1.4.1
7b	With the analysis of the Electrocardiogram (ECG) signal it is possible to predict heart problems or monitor patient recovery after a heart intervention. But The quality of biomedical signal is degraded mainly by many sources of noise so it is required to design a digital filter with Chebyshev approximation for the specifications$\alpha_p = 3dB, \alpha_s = 16dB, f_p = 1kHz, f_s = 2kHz.$ to overcome degradation by improving ECG signal quality for quality clinical diagnosis.	10	CO6	L3	2.1.3
8a	Design a filter with frequency response $H_d(e^{-j\omega}) = \begin{cases} e^{-j3\omega}, & \frac{-\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 0, & \frac{\pi}{4} < \lvert\omega\rvert \leq \pi \end{cases}$ using Hanning window for N=7	10	CO6	L3	3.4.1
8b	Design an ideal Hibert transformer with frequency response $H_d(e^{j\omega}) = \begin{cases} j, & -\pi \leq \omega \leq 0 \\ -j, & 0 \leq \omega \leq \pi \end{cases}$using rectangular window for N=11	10	CO6	L3	3.4.1


Bloom's level wise marks distribution
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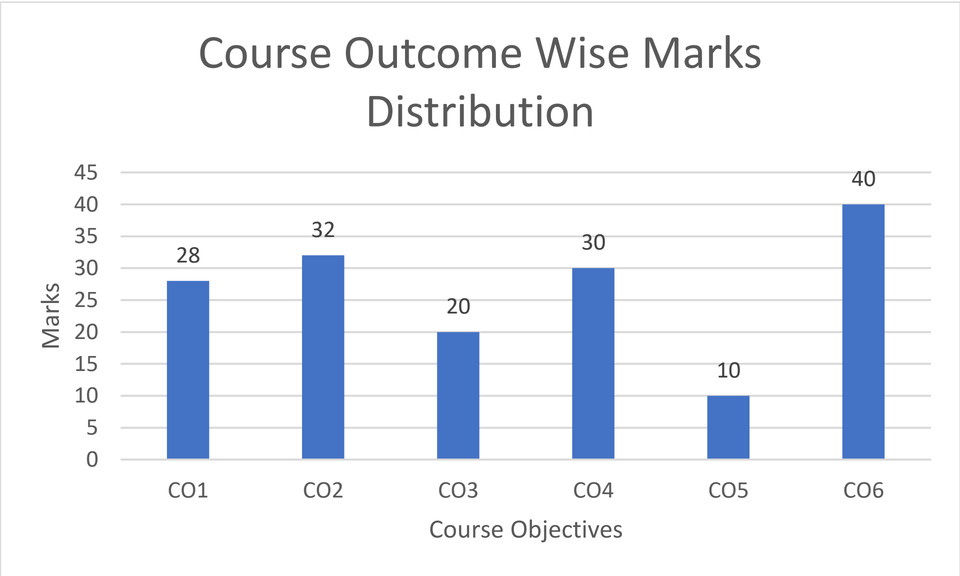
66%
Level 2
Level 3


Course Outcome Wise Marks Distribution
45
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35
30
25
20
15
10
5
0
Marks
28
32
20
30
10
40
CO1
CO2
CO3
CO4
CO5
CO6
Course Objectives

Course Name: Power Electronics

Course Outcomes

1. Apply basic volt-sec balance, amp-sec balance for inductors and capacitors present in a power converter so as to estimate output voltage and current of power converters
2. Design different dc-dc converters operating in continuous conduction mode for given specification of output voltage, output current and ripple voltage/current
3. Analyze square wave, PWM single phase and three phase voltage source inverters for output voltage amplitude and frequency control
4. Analyze single phase controlled rectifiers for R and RL load for both continuous and discontinuous conduction
5. Analyze single phase voltage controllers for R and RL load and explain static VAR control
6. Design MOSFET and IGBT gate drive circuits, BJT drive circuits, transistor and thyristor snubber circuits as well as cooling requirements for power semiconductor devices

Model Question Paper

Course: Power Electronics

Q.No	Question	Marks	CO	BL	PI Code
1a	State and prove ampere-second balance and volt-second balance. Also, establish the relationship between input voltage and output voltage for buck and boost type DC-DC converters by applying ampere-second balance to the capacitor.	10	2	L3	1.4.1
1b	A non-sinusoidal periodic voltage has a Fourier series of v(t) = 10 +20 cos(2π60t -250)+30 cos(4 π 60t +200) V. This voltage is connected to a load that is a 5Ω resistor and a 15-mH inductor connected in series. Determine the power absorbed by the load.	10	1	L2	1.4.1
2a	Show that rms value of a sinusoid is the peak value divided by $\sqrt{2}$. Give two examples to show that this is generally not the case for other periodic waveforms.	10	1	L2	1.4.1
2b	A buck converter has an input voltage that varies between 50 and 60 V and a load that varies between 75 and 125 W. The output voltage required by load is 20 V with allowable ripple of 1%. For a switching frequency of 100 kHz, Design system components to provide for continuous current for every operating possibility.	10	2	L3	3.1.6
3a	An electric resistance space heater rated at 1500 W for a voltage source of $v(t) = 120\sqrt{2}\sin(2\pi 60t)$ V has a thermostatically controlled switch. The heater periodically switches on for 5 min and off for 7 min. Determine (i) the maximum instantaneous power, (ii) the average power over the 12-min cycle, and (iii) the electric energy converted to heat in each 12 min cycle. A non-sinusoidal periodic voltage has a Fourier series of	10	1	L3	2.1.3

Q.No	Question	Marks	CO	BL	PI Code
3b	With necessary equivalent circuit diagrams and relevant waveforms of a SEPIC converter in CCM, derive expressions for voltage gain and current gain.	10	2	L2	1.4.1
4a	Explain how amplitude and harmonics are controlled in a single phase voltage source inverter simultaneously using relevant waveforms. Also derive an expression for the rms value of output voltage in terms of dc link voltage and delay angle.	10	3	L2	1.4.1
4b	A certain situation requires that either 160 or 75 W be supplied to a 48 V battery from a 120 V rms 60 Hz ac source. There is a two-position switch on a control panel set at either 160 or 75. Design a single circuit to deliver both values of power, and specify what the control switch will do. Specify the values of all the components in your circuit. The internal resistance of the battery is 0.1 Ω.	10	4	L3	2.1.3
5a	Design an inverter that has a PWM output across an RL series load with R=10Ω and L=20mH. The fundamental frequency of the output voltage must be 120 V rms at 60Hz, and the total harmonic distortion of the load current must be less than 8 percent. Specify the dc input voltage, the amplitude modulation ratio ma, and the switching frequency (carrier frequency). State the assumptions and approximations clearly involved in design process	10	3	L3	3.1.6
5b	Show that the controlled half-wave rectifier and full wave rectifier with a resistive load have the power factor of $pf_{HW}=\sqrt{\frac{1}{2}-\frac{\alpha}{2\pi}+\frac{\sin 2\alpha}{4\pi}}$ and $pf_{FW}=\sqrt{1-\frac{\alpha}{\pi}+\frac{\sin 2\alpha}{2\pi}}$ Also, explain the significance of power factor in rectifier circuits.	10	4	L2	1.4.1
6a	The full-bridge inverter has a switching sequence that produces a square wave voltage across a series RL load. The switching frequency is 60 Hz, Vdc =100 V, R=10 Ω, and L=25 mH. Determine (a) an expression for load current, (b) the power absorbed by the load, and (c) the average current in the dc source.	10	3	L2	1.4.1
6b	Design a circuit that will deliver 100 W to a 48 V dc source from a 120 V rms 60 Hz ac source. Give alternative circuits that could be used to satisfy the design specifications, and give reasons for your selection.	10	4	L3	3.1.6
7a	Explain application of ac voltage controller to maintain a unity power factor for varying load VAR requirements	08	5	L2	1.4.1
7b	Light-dimmer for ambient lighting consists of incandescent light bulb for use in USA (with 120 V rms, 50Hz). Bulb is measured to consume 500 W of power for particular lighting condition. Design suitable circuit to meet the requirements. Assume the bulb to be purely resistive with resistance of 15 ohms.	12	5	L3	3.1.6
8a	With a neat circuit diagram and waveforms, explain low side driver circuits for MOSFET and IGBT.	08	6	L2	1.4.1

Q.No	Question	Marks	CO	BL	PI Code
8b	For a BJT in its high switching frequency application of 50kHz, spike of 1A at the turn-on is observed. The current reduces to 0.2 A post switching transients in the on state. Design a circuit to cater to driving requirements for BJT for high switching application. (Design hints: Assume i) VBE=0.9V, ii) Control pulse input of 0-15V with duty ratio of 50%)	12	6	L3	3.1.6