NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

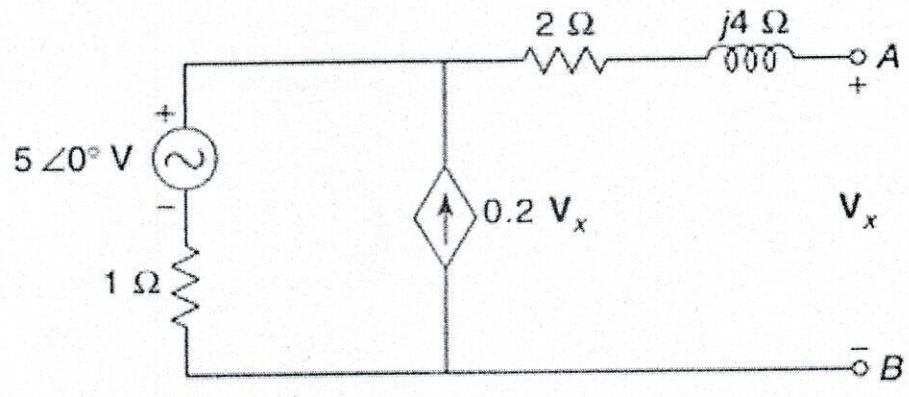
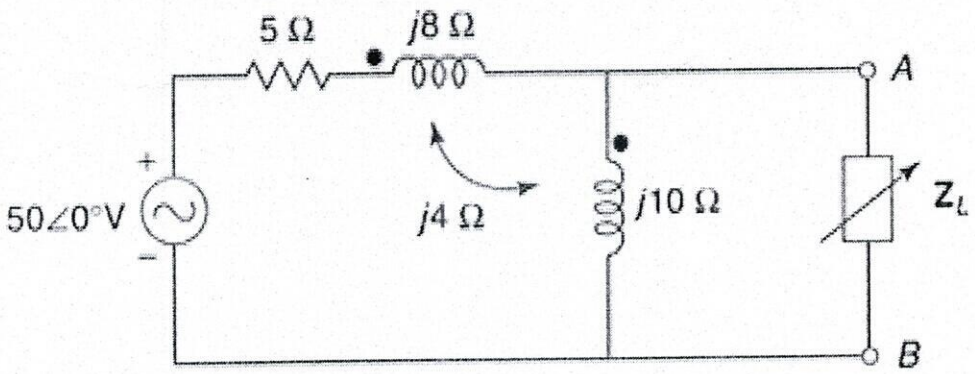
Odd Semester Mid-term Examination, 2023-24

Course Code: EEC301 Full Marks: 25

Course Name: Network Analysis and Synthesis Time: 90 minutes

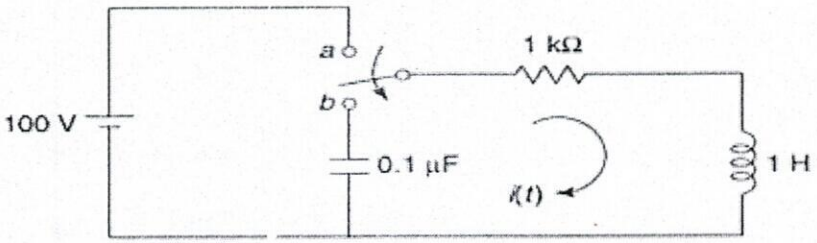
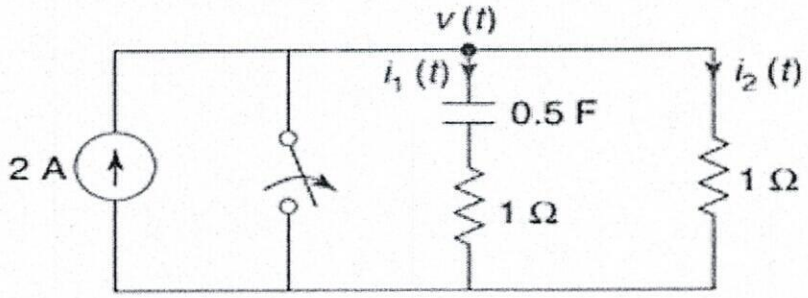
Question Paper No.: NITDGP/EEC301/1

Answer any five questions

Question No.	Body of the Question	Marks	Mapped CO
1	Obtain Thevenin's equivalent network across the terminal AB for circuit given below. 	5	CO1
2	Find the value of Z_L connected across the terminal A and B for the network shown below to received maximum power when (i) Z_L is a complex impedance and (ii) Z_L is pure impedance. 	5	CO1

Course Outcomes: Upon successful completion of this course, students should be able to:

- CO1: Apply the knowledge of basic circuital law, Network Theorem and network topology concepts in the formulation and solution of different electric network problems.
- CO2: Apply the Laplace transform to linear circuits and systems and analyze the signal synthesis, steady-state responses and transient response of DC and AC circuits using classical and Laplace transform methods.
- CO3: Evaluate two-port network parameters, their inter-relationship, different connections, representation two port network as T, Π and lattice form and also apply two-port network analysis in the design and analysis of filter and attenuator networks.
- CO4: Demonstrate the concept of complex frequency and analyze the behavior of the circuit's response in frequency domain, understand the significance of network functions, pole- zero plots, Bode plot etc. of one and two port networks.
- CO5: Synthesize one port network two port network function, analyze and design different filters.

3.	The incidence matrix is given below. Draw the corresponding graph. Develop the Tie-set and cutest matrix for the tree consisting of branch 1,2,3 and 4. $A=\begin{bmatrix}1 & 1 & 0 & 0 & 0 & 0 & 0\\ 0 & -1 & 1 & 0 & 1 & 0 & 0\\ 0 & 0 & -1 & 1 & 0 & 0 & 0\\ 0 & 0 & 0 & -1 & -1 & 1 & -1\end{bmatrix}$	5	CO1
4	State and prove the initial value theorem. Also verify the theorem for the function given below. $f(t)=2e^{-3t}\cos t$	5	CO2
5	In the network shown below the switch is changed from position 'a' to 'b' at time t=0. Solve I, $\frac{di}{dt}$, $\frac{d^2i}{dt^2}$ at t=0⁺ 	5	CO2
6	In the network shown below the switch is closed for a long time and at t=0, the switch is opened. Determine the current following through the capacitor. 	5	CO2

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-Term Examination, 2023-24

Course Code: EEC302
Course Name: Electrical & Electronic Measurement

Full Marks: 25
Time: 90 Minutes

Instructions: Answer any two questions from Group-A and any ten questions from Group-B

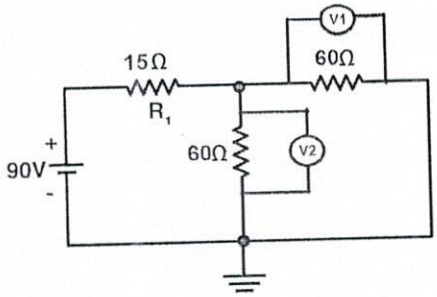
<table>
<tr><th>Question No.</th><th>Body of the Question</th><th>Marks</th><th>Mapped CO</th></tr>
<tr><td></td><td>Group-A (Answer any two questions)</td><td>5</td><td>CO1</td></tr>
<tr><td>1</td><td>A circuit is energized by 160V DC comprising of two resistances 15Ω and 25Ω in series. Two voltmeters are selected to measure the voltage across 15Ω resistance. The readings of two voltmeters are given below:
<table>
<tr><th>Voltmeter 1 reading (Volts)</th><th>Voltmeter 2 reading (Volts)</th></tr>
<tr><td>60.05</td><td>55.88</td></tr>
<tr><td>55.06</td><td>57.17</td></tr>
<tr><td>65.08</td><td>56.04</td></tr>
<tr><td>63.76</td><td>55.95</td></tr>
<tr><td>57.23</td><td>56.68</td></tr>
<tr><td>58.05</td><td>57.04</td></tr>
<tr><td>63.06</td><td>56.65</td></tr>
</table>
Comment on accuracy and precision of those two voltmeters.</td><td></td><td></td></tr>
<tr><td>2</td><td>Two voltmeters V1 and V2 having sensitivities of 1Ω/V and 5Ω/V respectively with full scale voltage range of 100V are employed to measure the voltages of the circuit given in Fig1:


Fig1
Determine the errors in readings of those voltmeters.</td><td>5</td><td>CO1</td></tr>
</table>

Course Outcomes
CO1: To develop an idea about the measurement processes
CO2: To learn the operating principle of ammeter, voltmeter, wattmeter and energy meter
CO3: To gain knowledge about Potentiometer and various resistance measurement techniques
CO4: To acquire knowledge of AC Bridges & Instrument Transformers
CO5: To get familiarize with CRO and introduction to Digital Instrumentation

3	The inductance and resistance of a pressure coil of a wattmeter is given by 5±10% mH and 800±10Ω respectively. The portion of pressure coil series resistance can utilized for compensation is given by 300±4%Ω. Design the compensating capacitor clearly mentioning its variation.	5	CO1,CO2
	Group-B (Answer any ten Questions)		
i)	Write three principal objectives of measurement and instrumentation.	1.5	CO1
ii)	What are basic features of the moving system of vibration galvanometer?	1.5	CO2
iii)	What are the advantages of Nalder Lipman type Synchroscope over Weston Synchroscope?	1.5	CO2
iv)	How can electrical equipment be protected against a stray magnetic field?	1.5	CO1
v)	What is purpose of using two resistances in three phase electrodynamometer type power factor meter?	1.5	CO2
vi)	Why does saturation of CT core indicate open circuit?	1.5	CO4
vii)	Why is bar primary CT regarded as single winding transformer?	1.5	CO4
viii)	Write one method of demagnetization of core of a CT.	1.5	CO4
ix)	What are the functions of diode bridges in ratio type frequency meter?	1.5	CO2
x)	What is the cause of flickering of lamp in Weston Synchroscope? How can you mitigate this problem?	1.5	CO2
xi)	What is the advantage of turn compensation of a CT?	1.5	CO4
xii)	Why is the scale of D Arson Val type mirror Galvanometer nonlinear?	1.5	CO2
xiii)	How can a CT employed for clearing a fault with the help of trip coil?	1.5	CO4
xiv)	Why is eddy current damping preferred over air friction damping in various indicating instruments?	1.5	CO1
xv)	What are the desired features of material of spring of indicating instruments?	1.5	CO1

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-term Examination, 2023-24

Course Code: EEC501
Course Name: Electrical Machines-II
Question Paper No.: NITDGP/EEC501/1

Full Marks: 25
Time: 90 minutes

Instructions: Answer any five questions.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Draw and explain the equivalent circuit of an Induction motor (b) Testing is conducted on a 30 HP, 820 rpm, 440 V, 3 phase, 50 Hz, star connected induction motor which gives the following results- Test name | Voltage (V) | Current (A) | Power (W) No load test | 440 | 14 | 1470 Blocked rotor test | 163 | 60 | 7200 Determine the equivalent circuit. ($R_1{:}R_2' = 1{:}2, X_1{:}X_2' = 1{:}1$)	2+3	CO5
2	(a) Explain the effect of input voltage variation and frequency variation on the slip-torque characteristics of Induction motor. (b) Rotor of a 3 phase, 50 Hz, 4 pole Induction motor takes 120 kW at 5 Hz. Determine the rotor speed and rotor copper loss.	3+2	CO5
3.	(a) Draw and explain different parts of the circle diagram of the simplified equivalent circuit of an Induction motor. (b) A 3 phase, 230 V, 50 Hz, 100 HP, 6 pole Induction motor is operated at rated condition with efficiency of 90%. It draws line current of 250 A. Core loss, stator copper loss and rotor copper loss are 1690 W, 2800 W, 1550 W. Determine the induced torque, shaft speed, and shaft torque.	2+3	CO5
4	Derive the expression of K_p and K_d. A three-phase, four-pole, 50 Hz star-connected alternator has 60 slots with two conductors per slot and has armature winding of the double-layer type. Coils are short pitched; that is, if one coil side lies in slot number 1, the other coil side lies in slot number 13. Find the useful flux per pole required to induce a line voltage of 6.6 kV.	2+3	CO1
5	Explain the armature reaction of alternator and also explain that the voltage regulation of alternator is negative at leading power factor of load.	5	CO1
6	A 415 V, 30 kVA, 50 Hz, three phase star connected alternator has the following open circuit test result. I_f (A) | 6 | 12 | 18 | 24 | 28 Line emf (V) | 282 | 408 | 435 | 459 | 574 An excitation of 8 A produced full load current in the armature on short circuit. If R_a= 0.5 ohm per phase, calculate the voltage regulation at full load and 0.707 power factor lagging and leading.	5	CO2

Course Outcomes: Upon successful completion of this course, students should be able to:

- CO1: Ability to design an AC machine and distinguish it from a DC machine.
- CO2: Ability to determine the alternator voltage regulation.
- CO3: Ability to Synchronize an alternator with an infinite bus.
- CO4: Ability to understand the starting methodology of a synchronous motor and determine the variation of synchronous machine performance with excitation.
- CO5: Ability to assess performance of an induction motor based on appropriate experimentation.
- CO6: Ability to start an induction motor by appropriate means & controlling its speed in effective way

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-Term Examination, 2023-24

Course Code: EEC502: Full Marks: 25

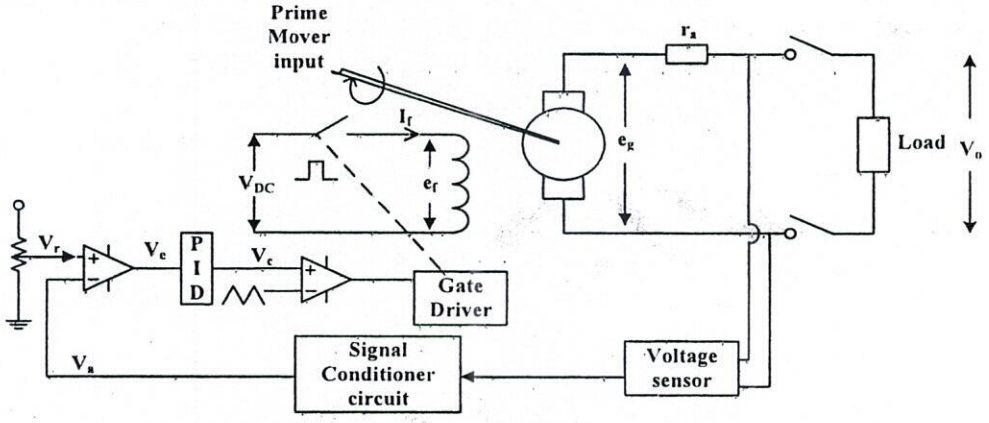
Course Name: CONTROL SYSTEMS Time: 90 Minutes

The figures in the margin indicate full marks.

Answer should be brief and to the point.

Notations used in the paper are considered to be standard

All questions of each GROUP must be answered at one place.

No.	**GROUP-A** **Answer any Two**	Marks	Mapped CO
1	(a) Explain how the output voltage of the DC generator (shown in Fig.1) will be maintained constant when the load is suddenly decreased.  Fig.1	2	CO1
	(b)Explain with suitable diagram the automatic liquid level control system and identify the different control components	3	CO1
	(c) Open-loop control action on a stable plant does not run the risk of instability, but negative feedback control action may result in instability problems. In spite of this fact, most of the industrial control schemes are based on negative feedback concept. Why?	1.5	CO1
2	(a)Justify that the gear train shown in the following Fig.2 is analogous to a transformer	3	CO1 CO2

Course Outcomes:

CO1: Acquire the knowledge and skills to identify the basic elements and structures of feedback control systems.

CO2: To develop the mathematical model of the physical systems.

CO3: To analyze the time response of the open loop & closed loop systems.

CO4: To analyze the stability of control systems using different tools.

CO5: To learn frequency response analysis and stability studies in Frequency Domain

CO6: To learn control system design using various kinds of compensator & to apply computer skills with MATLAB

CO7: To develop and analyze state space models

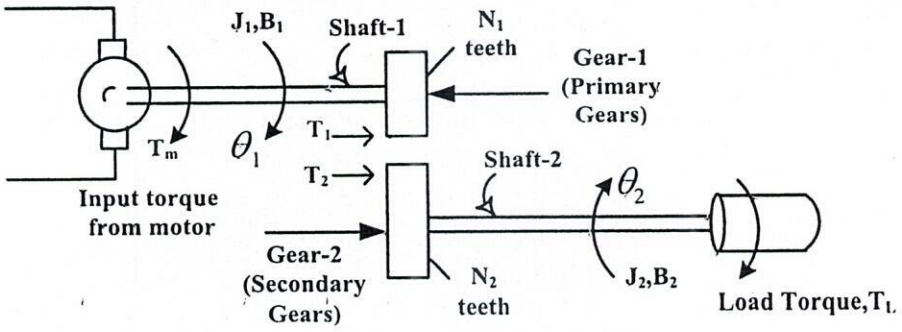


Fig.2

	(b)Develop the mathematical modelling of the following Moving Coil Voltmeter. The different parameters are as follows R=Coil resistance, L= Coil inductance, I(t) is the coil current, Td = Torque developed, $\theta(t)$ = Deflection of pointer, k_s = Spring Constant, J = Moment of inertia, k_b = Back emf Constant, k_t = Torque Constant.	3.5	CO1 CO2

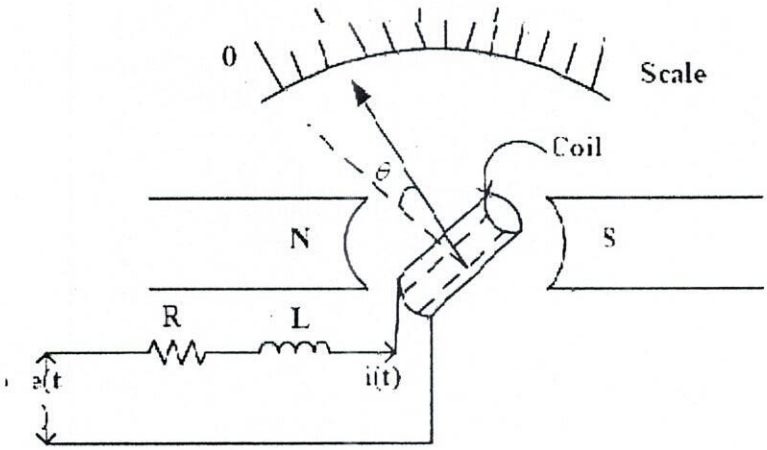


Fig.3

3	(a) A unity feedback system has open loop transfer function $G(s)=\frac{w_n^{\ 2}}{s(s+2\xi w_n)}$; $\xi<1$; Derive expressions for (i) rise time, (ii) peak time and (iii) settling time (2%) of the time response of the given system to the unit step input.	3	CO3
	(b) Determine the value of 'K' and 'H' of the closed loop system shown in Fig.4 so that the maximum overshoot in a unit step response is 25% and the peak time is 2 sec. Assume J= 1 kg-m^2	3.5	CO3

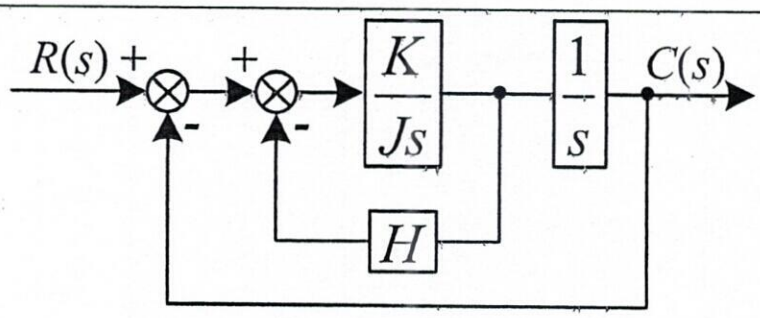
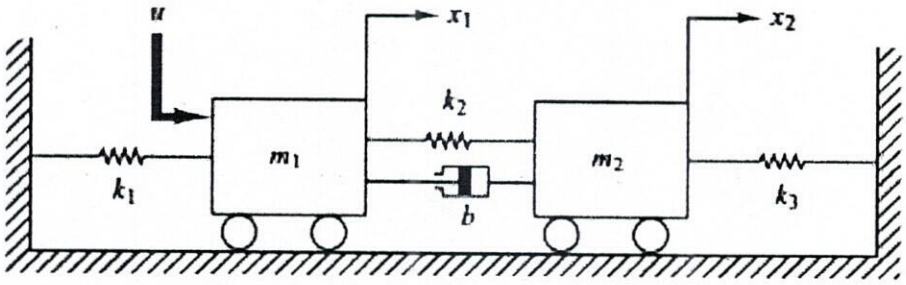


Fig.4

4	(a) (i) Show with examples how steady state accuracy will improve with the increasing of type of the system (ii) Write the limitations of error constant method for finding steady-state error.	2+ 1.5	CO3
	(b)The open-loop T.F of a unity feedback system is $G(s)=\frac{K(s+0.5)}{s(s+1)^2(s+0.25)}$. Determine the value of K so that the steady-state error is to be kept less than 0.05 for an input of $r(t)=2+5t$.	3	CO3
No.	**GROUP-B** **Answer any two**	Marks	Mapped CO
5.	(a) Derive the mathematical modeling of the mechanical system as shown in Fig. 5 in state space assuming displacements as outputs and $u(t)$ as the external input force.	3	CO1 CO2 CO7
	 Fig. 5	3	CO2 CO7
	(b) Obtain the transfer function $\frac{X_1(s)}{U(s)}$ using state space method.		
6.	(a) Derive the transfer function of the output voltage to input voltage $\frac{E_o(s)}{E_i(s)}$ for the electronic system as shown in Fig. 6.	3	CO1 CO2

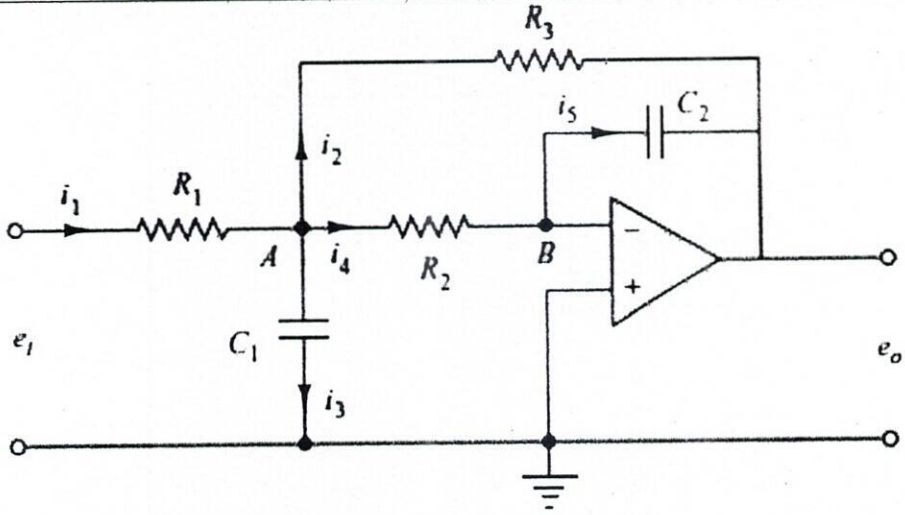


Fig. 6

	(b)Obtain the transfer function of a system described in state space as follows. $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t);\ y(t) = [1 \quad 0]x(t) + 2u(t)$ Also comment on the stability of the system.	3	CO2 CO4 CO7
7.	(a) Represent the dynamics of the electrical system shown in Fig.7 in block diagram using integrators, summers and gains only.	3	CO1 CO2

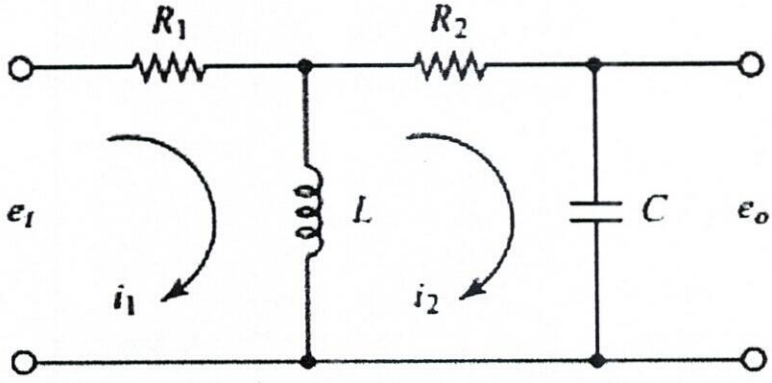
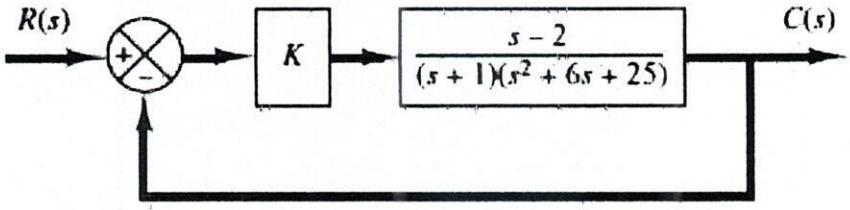


Fig. 7

	(b) Using block diagram reduction rule, obtain the transfer function $\frac{E_o(s)}{E_i(s)}$.	3	CO1 CO2

8.	(a) Consider the closed loop system as shown in Fig. 8. Determine the range of K for stability assuming $K > 0$.	3	CO4
	 Fig.8		
	(b) Tell how many roots of the following polynomial are in the right half-plane, in the left half-plane, and on the $j\omega$-axis. $\Delta(s) = s^5 + 3s^4 + 5s^3 + 4s^2 + s + 3$	3	CO4

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-Term Examination, 2023-24

Course Code: EEC 503
Course Name: POWER SYSTEMS-II

Full Marks: 25
Time: 90 Minutes

Instructions: Answer **all questions** from **Part-I** and any **one question** from **Part-II**.
All parts of a question should be answered in sequence.

	Part-I	Marks	Mapped CO
1.	Show a typical scheme of primary relaying for protecting power systems elements.	2	CO4
2.	Draw a schematic diagram of the trip circuit and explain it in brief.	2	CO4
3.	With the help of a suitable diagram, briefly explain the remote backup protection scheme.	2	CO4
4.	Briefly explain the role of directional relays in protecting parallel feeders.	2	CO4
5.	What are the disadvantages of Time graded protection scheme?	2	CO5
6.	"The current-graded scheme is used where the impedance between two substations is moderately high" Justify the statement with a suitable explanation and diagram.	2	CO5
7.	Develop the basic operating characteristic of the Impedance relay from the universal torque equation.	2	CO5
8.	Which distance relay's operation is insensitive to the arc resistance, and how?	2	CO5
9.	Draw and explain the **control circuit** of Three Zone Distance Protection of Transmission Lines using Mho type relay.	2	CO5
10.	"A Mho type relay is inherently directional in nature." Justify the statement with a suitable explanation and diagram.	2	CO5
	Part-II		
11.	Explain the working principle of Solkar scheme of Pilot wire protection system with a suitable diagram.	5	CO5
12.	Develop the expression of the operating torque of induction-type relays. Show the necessary vector diagram.	5	CO4

Course Outcomes
On completion of the course, the students will be able to:

- CO1: analyze the behavior of the power systems under symmetrical and unsymmetrical fault conditions and select suitable protective schemes and circuit breakers, in addition to deployment of suitable current limiting reactors at strategic locations for expansion of the existing systems.
- CO2: select bus bar arrangements suitable for any particular application in substations or generating stations. Besides, they also become acquainted with the layout of substation equipment.
- CO3: be familiarized with different types of circuit interrupting devices along with their constructions, properties, operating principles, testing and appropriate placements.
- CO4: be acquainted with various types of relays and their deployment, their characteristics, connections etc.
- CO5: understand and design the diverse schemes used in practice to protect power systems transmission lines, generators, transformers, bus bars etc.

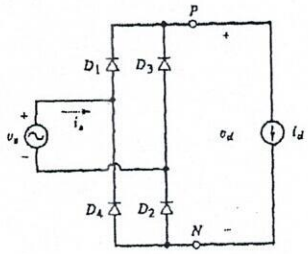
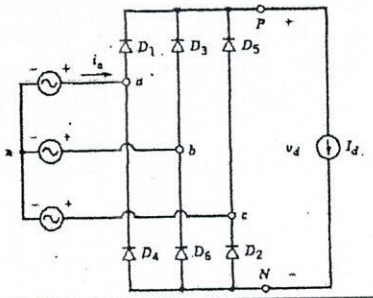
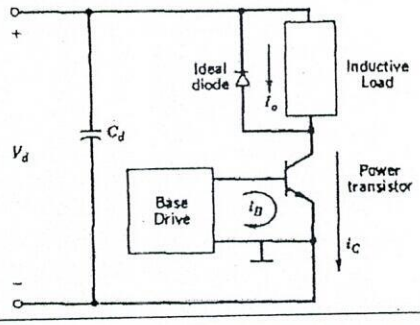
NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-Term Examination, 2023-24

Course Code: EEC 504
Course Name: Power Electronics

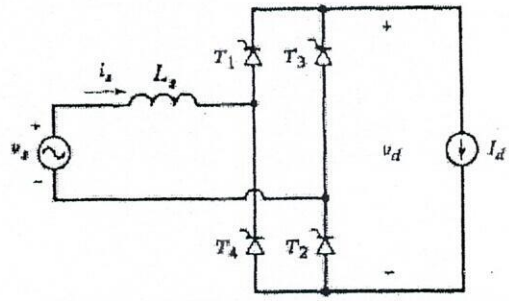
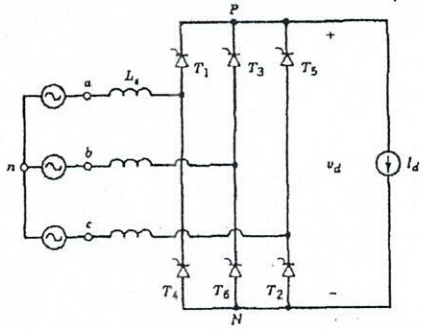
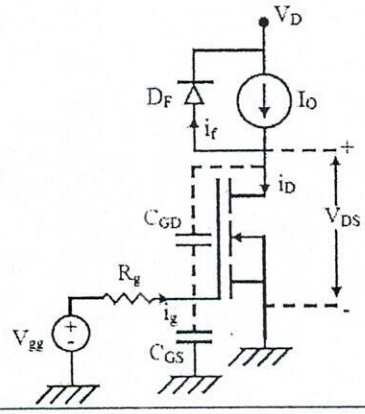
Full Marks: 25
Time: 90 Minutes

Instructions: Answer any five questions.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) Explain the reverse recovery current requirement by a power diode and show the nature of the diode current and voltage with respect to time, while subjected with a reverse bias voltage. (b) Consider a single-phase rectifier is operated with power diodes as per the following figure.  The input voltage for the circuit is 230V, 50 Hz., and the load current is 10 A. Find the value of the average current flowing through any one single diode in this operation.	2 3	CO1 CO2
2	Find the THD in line current of a three phase full bridge rectifier of the following figure, supplying constant current of 15 Amp. Consider the input is 400 V, 50 Hz, balanced three phase supply.  	5	CO2
3	Draw and explain the base voltage, base current, device voltage, and device current transient characteristics during turn on and turn off of a BJT embedded in the following circuit.  	5	CO1

Course Outcomes

- CO1: Acquire an idea about semiconductor devices
- CO2: To learn the detail operation of the ac-dc components
- CO3: To learn the detail operation of the dc-dc components
- CO4: To learn the detail operation of the dc-ac components
- CO5: To learn the detail operation of the ac-ac components
- CO6: To identify the utilisation of the components in Industry

4	A single-phase fully controlled rectifier is operated with firing angle of 30^0 for the following circuit, where the load current is 10Amp and the input voltage is 230v, 50 Hz. For a finite value of source inductance (50 μH) derive the average output voltage of the system.  	5	CO1 CO2 and CO5
5	Find the commutation angle for the three phase converter if output voltage is 500 V, and power 500 kW, and input voltage is 400 V, 50 Hz. Consider the source inductance per phase is 25 μH.  	5	CO1 and CO2
6	Draw the turn on transient voltage and current waveforms of gate voltage, gate current, device voltage, and device current for a MOSFET working with clamped inductive load, as per the following figure. Draw and explain different equivalent circuits during these intervals.  	5	CO1 and CO3
7	A dc-dc buck converter is working with output voltage of 24 V and current 2 Amp. Considering the input as 36 V and switching frequency as 5 KHz, derive the peak to peak output voltage ripple of the converter. Consider the converter inductor and capacitor as 30 mH and 500 μF in this case.	5	CO3