Gb
15/12/14

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

Re-Examination

Second Half 2014

ME (Power Elet. & Powe. Suply.). (Elect) Sem-I. Re. exam

Total Marks: **100**

Duration : **3 Hours**

CLASS/SEM: **M.E. (PEPS) / Sem I** (Elect).

SUB : **Advanced Power Electronics**

- Attempt any **FIVE** question out of **SEVEN** questions
- Answers to all sub questions should be grouped together
- Figures to the right indicate full marks
- **Assume suitable data if necessary and justify the same.**

MASTER FILE

Q.1a) Draw the output voltage and load current waveforms for single phase bridge inverter for:
(i) R-L load
(ii) Pure L load
Comment on the conduction of the diode connected in parallel with the device. **(10)**

b) A three phase fully controlled bridge rectifier is fed with 400 V, 50 Hz supply. The source inductance is 1 mH per phase. Calculate the average dc voltage of the bridge when the load current is 100 A and firing angle alpha is 30 degrees. (Assume load current is continuous and constant). **(05)**

c) Draw the circuit and derive the duty ratio of buck converter **(05)**

Q. 2a) For six step operation of three phase inverter, draw the following waveforms for delta connected load.
(i) Pole voltages
(ii) Line voltages
(iii) Line currents
(v) What is the spectrum of harmonics present in the pole voltage? **(14)**

b) Draw the output voltage and current waveform for controlled half wave rectifier with pure inductive load. Derive the expression for average output voltage. **(06)**

Q.3a) Explain the operation of switched mode rectifier. **(10)**

b) A separately excited dc motor is supplying constant torque load and is controlled by single phase fully controlled rectifier. Discuss the variation of firing angle alpha for the speed control. Draw the output voltage and current waveform. **(10)**

Q.4a) For three phase, full wave controlled rectifier, draw the waveform of instantaneous output voltage and instantaneous voltage across any one thyristor for:

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Advanced Power Electronics.

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firing angle, α=60 degree. **(15)**

Note: Use graph paper

b) A buck regulator is operating with frequency 20 kHz and input voltage is 100V. Determine the on time of the switch for the output voltage is 70V. **(05)**

Q.5a) Derive the expression for times T1, T2 and Tz applied in one sample time in space vector modulation technique. **(12)**

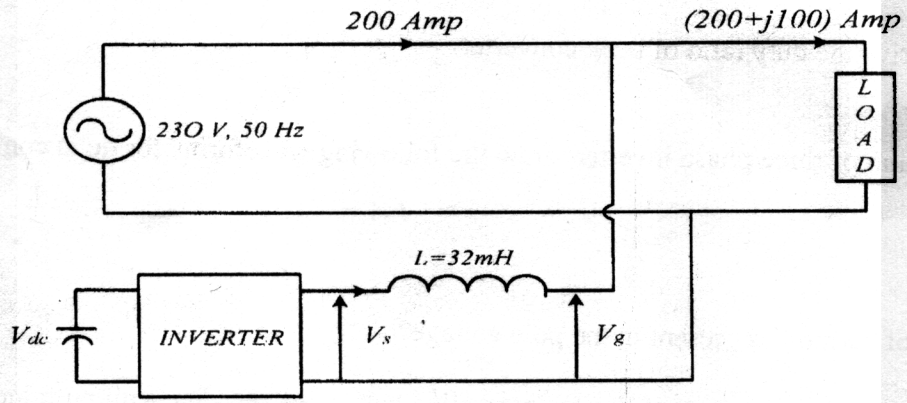
b) Explain the sine-triangle PWM used for the control of single phase inverter. **(08)**

Q.6a) Explain the operation and working of boost regulator with relevant waveforms. **(14)**

b) Explain the limitations of line commutated rectifier. **(06)**

Q.7a) Explain the operation of single phase full wave uncontrolled rectifier with R-L-E load. Draw the output voltage and source current waveform. Derive the expression for average output voltage. **Assume load current is continuous and constant.** **(08)**

b) Fig. below shows the single phase bridge inverter acts as a reactive power compensator. Assume the inverter circuit and inductor are lossless. For the given condition, draw the phasor diagram and calculate the inverter output voltage, V_s. Assume inverter is operating in square wave mode, calculate, V_{dc}. **(04+04+04)**



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Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

M.E (PEPS) Power Electronics & Power Systems
Sem I

Second Half 2014

Total Marks: **100**

Duration : **4 Hours**

CLASS/SEM: **M.E. (PEPS) / Sem I**

SUB : **Advanced Power Electronics**

- Attempt any **FIVE** question out of **SEVEN** questions
- Answers to all sub questions should be grouped together
- Figures to the right indicate full marks
- **Assume suitable data if necessary and justify the same.**

MASTER FILE.

Q.1a) Draw the output voltage and load current waveforms for single phase bridge inverter for:
(i) Lagging P.F. load
(ii) Leading P.F. load
Comment on the requirement of devices used in inverter for the above load. **(10)**

b) A three phase fully controlled bridge rectifier is fed with 400 V, 50 Hz supply. The source inductance is 10 mH per phase. Calculate the average dc voltage of the bridge when the load current is 100 A and firing angle alpha is 30 degrees. (Assume load current is continuous and constant). **(06)**

c) Compare buck, boost and buck-boost regulator. **(04)**

Q. 2a) For six step operation of three phase inverter, draw the following waveforms for star connected load.
(i) Pole voltages
(ii) Line voltages
(iii) Phase voltages
(iv) Line currents
(v) What is the spectrum of harmonics present in the pole voltage? **(15)**

b) Draw the output voltage and current waveform for controlled half wave rectifier with pure inductive load. Derive the expression for average output voltage. **(05)**

Q.3a) What are the issues in line commutated rectifier. How these issues are overcome in switched mode rectifier, explain with circuit and relevant waveforms. **(04+10)**

b) A separately excited dc motor is supplying constant torque load and is controlled by single phase fully controlled rectifier. Explain the need of control of firing angle alpha beyond 90 degree. Justify your answer. **(06)**

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M.E (Elect) Sem I Power Electronics & Power systems Sem I 17/11/14

Q.4a) For three phase, full wave controlled rectifier, draw the waveform of instantaneous output voltage and instantaneous voltage across any one thyristor for:
firing angle, α=30 degree and overlap angle, μ=30 degree **(15)**
Note: Use graph paper

b) A boost regulator with a pulse width of 100μs is operating on 500 V dc supply. Compute the load voltage if the blocking time of the device is 40μs. **(05)**

Q.5a) Prove that the six active vectors in VSI occupies the six vertices of hexagon. What should be the maximum magnitude of space vector so that the locus of space vector synthesized using space vector modulation technique (SVM) is a circle. What will be the corresponding magnitudes of line and phase voltages. **(10+02+03)**

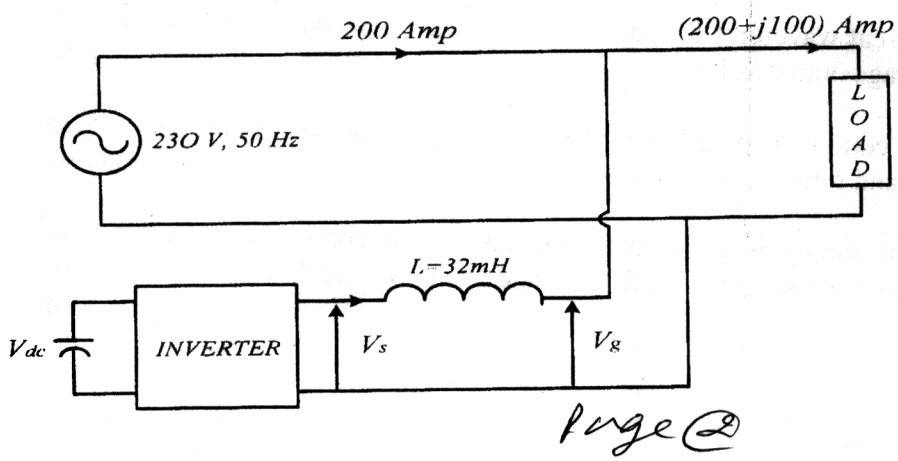
b) A three phase Induction Motor with rating 400V and 50 Hz is connected to the constant torque load with variable speed. The available source is 200V dc. Suggest the suitable power electronics converter circuits. **(05)**

Q.6a) "Stator voltage control is very popular in I.M. where, $T_L \alpha (\omega_m)^2$" justify. Draw the power electronic circuit for ac voltage regulator for speed control of Single Phase Induction Motor. Draw the output voltage and source current waveform. **(14)**

b) The separately excited dc motor is used in speed reversible electrical drive. Suggest the suitable power electronics converter for the four quadrant operation of a drive and draw the diagram. Show the four quadrants of drive (quadrants showing voltage and current). **(02+02+02)**

Q.7a) Explain the operation of single phase full wave half controlled rectifier with R-L-E load. Draw the output voltage and source current waveform. Derive the expression for average output voltage. **Assume load current is continuous and constant.** **(08)**

b) Fig. below shows the single phase bridge inverter acts as a reactive power compensator. Assume the inverter circuit and inductor are lossless. For the given condition, draw the phasor diagram and calculate the inverter output voltage, Vs. Assume inverter is operating in square wave mode, calculate, Vdc. **(04+04+04)**



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Electrical with
ME (Power system & Power Electronics) Sem - I

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering, Andheri (W), Mumbai 400 058

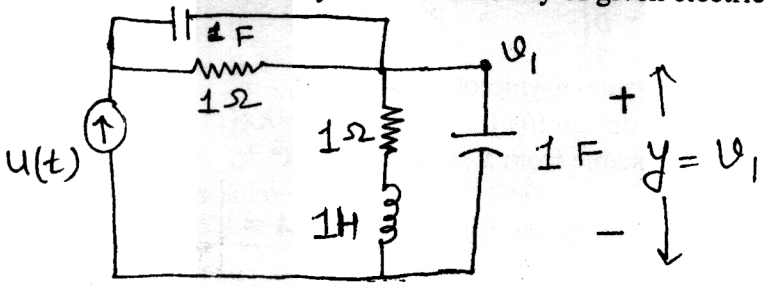
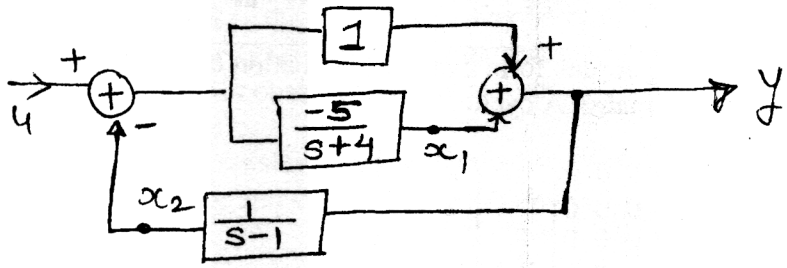
End Semester Examination

Class: M.E.(Electrical PEPS) Sem I — **Time:** 4 Hr.

Subject: Dynamics of linear systems — **Marks:** 100.

Note: 1) Solve any five. MASTER FILE.

2) Assume suitable data if necessary.

1	a. Evaluate the series e^{At} if $A=\begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}$	[04]
	b. If $\bar{A} = T^{-1}AT$ show that $\bar{A}^k = T^{-1}A^kT$ and $e^{At} = Te^{\bar{A}t}T^{-1}$	[06]
	c. Check controllability and observability of given electrical network 	[10]
2	a. Choose state variables as shown in fig 	[12]
	i) Write the state equation? ii) Is this system realization controllable? Observable? iii) What is the transfer function from u to y? iv) Is the realization minimal?	
	b. Prove that similarity transformation does not affect controllability as well as observability	[08]

M.E. (Electrical PEPS) Sem I

Dynamics of linear systems.

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3	a. Given a system described by state equation $\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix} = \begin{bmatrix}-1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}-2\\ 1\end{bmatrix} u(t)$ with $x_1(0) = 10, x_2(0) = 5$ and $y(t) = [0 \quad 1]\, x(t)$ calculate x_1, x_2 and $y(t)$ for $t \geq 0$, where $u(t)$ is a unit step input.	[10]
	b. Consider the undamped harmonic oscillator with $\dot{x}_1(t) = x_2(t)$ and $\dot{x}_2(t) = -\omega_0^2 x_1(t) + u(t)$. Using an observation of velocity $y = x_2$, design state feedback compensation to control the position x_1. Place the state feedback controller poles at $s = -\omega_0 \pm j\omega_0$.	[10]
4	a. If $\{A, b, c\}$ and $\{\bar{A}, \bar{b}, \bar{c}\}$ are related by constant transformation T, show that they have same transfer function.	[5]
	b. Consider a linear system $\dot{x}(t) = Ax(t) + Bu(t)$ where $A = \begin{bmatrix}-2 & 0 & 0\\ 3 & -5 & 0\\ 9 & 0 & 7\end{bmatrix} \qquad B = \begin{bmatrix}1\\ 2\\ 1\end{bmatrix}$ i) Is the system asymptotically stable? ii) Can we design $u(t)$ of the form $u = kx(t)$ so as to transform system stable from x_0 to any $x_1 \in \mathbb{R}^3$?	[5]
	c. Find the Eigen values and Eigen vectors if $A = \begin{bmatrix}1 & 0 & 0\\ 2 & 3 & -1\\ 2 & 2 & 1\end{bmatrix}$.	[5]
	d. Obtain general solution of $\frac{d^2x}{dt^2} + 4x = 3 + 2cos2t$. Find the particular solution for which x=0 and $\frac{dx}{dt} = 0$ when t=0.	[5]
5	a. Is the following Jordan form dynamical equation controllable and observable? Is matrix A cyclic? $\dot{X} = \begin{bmatrix}2&1&0&0&0&0&0\\ 0&2&0&0&0&0&0\\ 0&0&2&0&0&0&0\\ 0&0&0&2&0&0&0\\ 0&0&0&0&1&1&0\\ 0&0&0&0&0&1&0\\ 0&0&0&0&0&0&1\end{bmatrix} X + \begin{bmatrix}2&1&1\\ 2&1&1\\ 1&1&1\\ 3&2&1\\ -1&0&0\\ 1&0&1\\ 1&0&0\end{bmatrix} u$ $y = \begin{bmatrix}2&2&1&3&-1&1&1\\ 1&1&1&2&0&0&0\\ 1&1&1&1&0&1&0\end{bmatrix} X$	[12]

M.E. (Electrical Peps) Sem I

Dynamics of linear systems.

24/11/14.

		b. What is the controllability index for a MIMO system? Calculate the controllability index of the given system? $\dot{X} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 3 & 0 & 0 & 2 \\ 0 & 0 & 0 & 1 \\ 0 & -2 & 0 & 0 \end{bmatrix} X + \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} u$ $y = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} X$	[08]
6		a. State and prove Lyapunov theorem for stability. b. Is a system with transfer function $\hat{g}(s) = \frac{e^{-2s}}{s+1}$ BIBO stable? c. Consider a system with transfer function $\hat{g}(s) = \frac{s-2}{s+1}$. What are the steady state response excited by $u(t) = 3$, for $t \geq 0$ and by $u(t) = sin\ 2t$, for $t \geq 0$ d. Are the homogenous state equations i) $\dot{X} = \begin{bmatrix} -1 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} X$ ii) $\dot{X} = \begin{bmatrix} -1 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} X$ Marginally stable? Asymptotically stable?	[05] [05] [05] [05]
7		a. Design an observer for the plant $G(s) = \frac{10}{(s+2)(s+6)(s+12)}$. Operating with 10% overshoot and 2 sec peak time. Design an observer to respond 10 times as fast as the plant. Place the observer 3rd pole 20 times as far from the imaginary axis as the observer dominant poles. Assume the plant is represented in observer canonical form. b. Obtain the transfer function of combined observer controller compensator and comment on the result. c. Comment on the stability of the combined observer controller compensator.	[10] [07] [03]

Lib
21/11/14

BHARARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar Andheri (West), Mumbai 400 058

(An Autonomous Institution Affiliated to University of Mumbai)

ME (Power ~~Electronics~~ Power System)

END SEM EXAMINATION

CLASS/SEM: **ME (PEPS)/ I** M.E (ETC) Sem I

Subject: **Modeling and Analysis of Electrical Machines**

Total Marks: **100**
Duration : **4 hours**
Date : **21/11/2014**

- Attempt any **five** out of the **seven** questions.
- Answer to all sub questions should be grouped together.
- Best of luck!

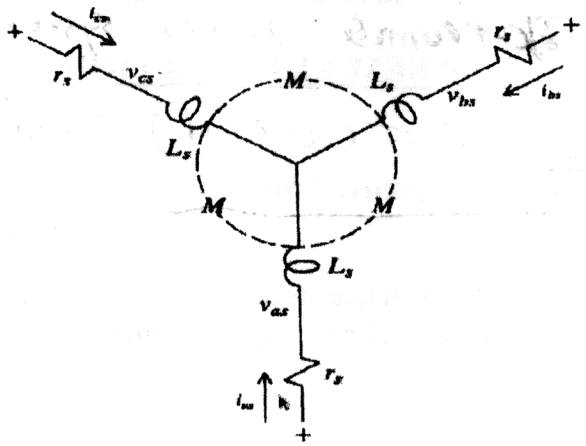
MASTER

Q.1	A) Show that the energy stored in a magnetic field is equal to the area between the ø-F curve and the flux axis.	(6 Marks)
	B) A solenoid relay is operated from a 110V dc supply and the 5000 turn coil resistance is 5.5 kΩ. The core diameter of the relay is 20 mm and the gap length is 1.5 mm, the armature being stationary. The gap faces may be taken as parallel and the permeability of the ferromagnetic parts as very high. Find: i) The air gap flux density ii) the coil inductance.	(4 Marks)
	C) Show that in a singly excited system the mechanical work done is equal to the area enclosed between the two ψ-I characteristics in initial and final position and the vertical ψ-I axis locus during the slow movement of the rotor. Also derive an expression for the torque in case of slow and instantaneous movement of the rotor.	(10 Marks)
Q.2	A) Derive an expression for the torque in a doubly excited system.	(10 Marks)
	B) Write the voltage and torque equations for i) Separately excited DC machine ii) Shunt connected DC machine. iii) Series connected DC machine. iv) Compound connected DC machine.	(10 Marks)

M. E (Elect) Sem I Power Electronics & Power System

Modelling & Analysis of Electrical m/c

21/11/14

Q.3	A) Convert the stationary 3 phase RLM circuit shown in figure below into dq0 frame and derive equivalent circuits. The frame is rotating at ω rad/sec. 	(10 Marks)
	B) i) What assumptions are made while deriving an expression of torque for singly or doubly excited system?	(2 Marks)
	ii) What are the advantages of transformation?	(2 Marks)
	iii) The ψ-I relationship for an electromagnetic system is given by $i = \left(\frac{\psi x}{0.09}\right)^2$ which is valid for the limits $0 < i < 4\ A$ and $3 < x < 10$ cm. For current i= 3A and air gap length x=5cm, find the mechanical force on the moving part using energy and coenergy of the field.	(6 Marks)
Q.4	A) If x and y are the reference frames rotating at an angular velocity $\omega_x\ rad/s$ and $\omega_y\ rad/s$ respectively, then show that $(x_k{}^y)^{-1} = (x_k{}^y)^T$.	(10 Marks)
	B) The transformation for a 2 phase set to the arbitrary reference frame is $f_{qds} = k_{2s} f_{abs}$ where $(f_{qds})^T = [f_{qs}\ f_{ds}]$ and $(f_{abs})^T = [f_{as}\ f_{bs}]$ $k_{2s} = \begin{bmatrix} cos\theta & sin\theta \\ sin\theta & -cos\theta \end{bmatrix}$ Express the voltage equations in the arbitrary reference frame for a 2 phase resistive circuit if i) $r_a = r_b = r_s$ and $r_a \neq r_b$.	(4 Marks)
	C) Represent a purely capacitive circuit capacitors in dq0 frame rotating at ω rad/s.	(6 Marks)
Q.5	A) Show that the expression for the electric torque of the Kron's primitive machine is	(10 Marks)

M.E (Extc) Sem I
Power Electronics & Power System modelling & Analysis & Electrical Machine 21/11/13

	$T_e = M_d i_{ds} . i_{qr} - M_q i_{qs} . i_{dr} + (L_{dr} - L_{qr}) i_{dr} . i_{qr}$ B) A permanent magnet dc motor is rated at 6V with the following parameters: $r_a = 7\Omega$, $L_{AA} = 120mH, J = 1.06\ X\ 10^{-6}\ kg\ m^2$, $k_v = 1.41\ X\ 10^{-2}\ V.s/rad$. According to the motor information sheet, the no-load speed is approximately 3350 r/min and the no-load armature current is approximately 0.15 A. Calculate the damping coefficient B_m. If the machine is operating with load torque T_L of 3.53 X 10^{-3}, then calculate efficiency and losses.	(10 Marks)
Q.6	A) Consider a 2 pole, 3 phase, wye connected symmetrical induction machine. Derive the voltage equations in arbitrary reference frame.	(10 Marks)
	B) Show that the expression for the electromagnetic torque of a 3 phase Induction machine is $T_{em} = \frac{3}{2}\frac{P}{2} M(i_{qs} i'_{dr} - i_{ds} i'_{qr})$	(10 Marks)
Q.7	A) Derive an expression for the force in a singly excited linear actuator.	(10 Marks)
	B) Consider a 2 pole, 3 phase, wye connected symmetrical induction machine. Derive the voltage equations in machine variables form.	(10 Marks)

HB
26/11/14

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

Second Half 2014

ME (Elect). Sem – I

Total Marks :100
Duration : 4 Hours

CLASS/SEMESTER: - ME(POWER ELECTRONICS & POWER SYSTEMS) / I Master

SUBJECT:- POWER SYSTEM PLANNING & RELIABILITY

Attempt **Five** question from the **Seven** questions. **Qs.I to Qs.VII**
Answers to all sub questions should be grouped together.
Figures to the right indicate full marks.
Assume suitable data if required.

Qs.I

a. Name the three basic types of tools used in power system planning & state the basic functions of these tools. **(10)**

b. What are the Organization models based on different functions of electricity supply? Show their structural models & clearly mention the difference in their functioning. **(10)**

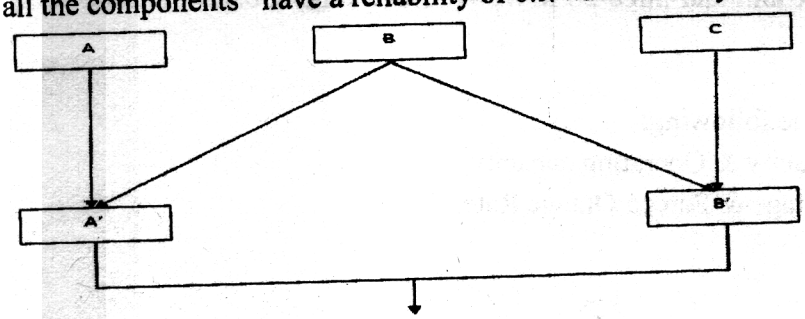
Qs.II

a. With reference to power system planning explain the following terms:
   1. Detailed Feasibility Report & its appraisal **(05)**
   2. Least-cost planning **(05)**

b. With reference to load forecasting explain the following terms:
   1. Important fators that are taken into account for medium- and long-term forecasts **(05)**
   2. Forecasting methods & Techniques **(05)**

Qs.III

a. In the system shown, system success requires that one of the following paths must be available A-A', B-A', C-B', B-B'. Write an expression for the reliability of the system. If all the components have a reliability of 0.9 what is the system reliability? **(10)**



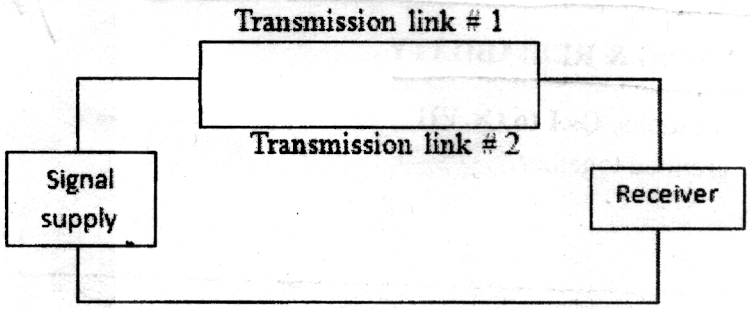
ME (Elect / PSPS), Sem-I, Power System Planning & Reliability

26/11/14

Qs.III

b. The system shown below has the following assumed average failure rates:

	%/1000 hours
Signal supply	1.0
Transmission link # 1	1.5
Transmission link # 2	2.7
Receiver	1.1



If the above circuit is left operating for a period of 1000 hours, what is the probability of it still operating at the end of this time? If transmission link # 2 is removed from service, what is the probability of the system operating at the end of a 1000 hour period? **(10)**

Qs.IV

a. Define the following terms with reference to reliability:

1. Instantaneous failure density & instantaneous hazard rate **(05)**
2. Mean Time to Failure **(05)**
3. Bathtub curve **(05)**

b. 'Probability of failure during any interval 't' is independent of the prior operating time within the useful life period' Justify the statement. **(05)**

Qs.V

a. Define system adequacy & system security with reference to reliability: **(05)**

b. Define capacity outage probability table (**COPT**) & obtain the COPT for a system having three identical generator units each having a capacity of 20 MW & FOR 2%. **(05)**

c. A system having 4-generating unit with an installed capacity of 100 MW consisting of one 40 MW, 4% FOR unit and three 20 MW, 4% FOR units. Obtain the capacity model in the form of a COPT. **10)**

Qs.VI

a. Define/Explain the following:

1. Static capacity & Operating capacity. **(05)**
2. Forced outage & Forced Outage Rate. **(05)**

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ME(Elect)(PEPS), Sem-I, Power System planning & Reliability

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Qs.VI

b. Obtain the Loss of Load Expectation (LOLE) index of a system having the following data:

Table 2.1: System data

Unit no.	capacity (MW)	failure rate (f/day)	repair rate (rep/day)
1	25	0.01	0.49
2	25	0.01	0.49
3	50	0.01	0.49

Table 2.2: Load data

daily peak load (MW)	57	52	46	41	34
no. of occurrences	12	83	107	116	47

(10)

Qs.VII

a. Consider a 100 MW system with the following data & obtain COPT using Recursive Algorithm :

Three 20 MW units, $\lambda = 0.4$ f/yr, $\mu = 9.6$ rep/yr each, & one 40 MW unit with $\lambda = 0.4$ f/yr and $\mu = 9.6$ rep/yr. Consider also that the 20 MW units are loaded first followed by the 40 MW unit. **(10)**

b. If the 40 MW unit exists in 3 states as follows then Obtain the capacity model in the form of a COPT. **(05)**

state (i)	capacity out C_i (MW)	state probability (pi)
1	0	0.95
2	20	0.04
3	40	0.01

c. Explain Practical state model of a generator unit & the unit availability & unavailability **(05)**

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19/11/14

M. Electrical) Sem I Power Electronics & Power Systems

BHARATIYA VIDYA BHAVAN'S

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END SEMESTER

SEM/CLASS: **I/ME ELECTRICAL.** TOTAL MARKS: **100**

SUBJECT: **Protection in Power System** DURATION: **4Hours.**

DATE **November 2014.**

MASTER

Note: Solve any FIVE questions.

Q1: a> What are the advantages and limitations of static relays? (05)

b> With a neat diagram explain static definite time over current relay. (05)

c> Explain static impedance relay using amplitude comparator and phase comparator. (05)

d> Explain static reactance relay using amplitude comparator and phase comparator. (05)

Q2: a>What are different types of distance relays? Compare their merits and demerits. Discuss their field of applications? (05)

b> Discuss essential qualities of protection. (05)

c> Explain static MHO relay using amplitude comparator and phase comparator. (05)

d> What is quadrilateral characteristics? How is it realized using phase comparator? (05)

Q3: a> Discuss limitations of circulating current pilot wire scheme. How are they rectified in opposed voltage pilot wire scheme? Discuss limitations of opposed voltage pilot wire scheme. (04)

b> What is unit protection? What are its merits and demerits? How does carrier aided distance protection give better performance than carrier current protection? (04)

c> What is carrier blocking scheme? Discuss its merits and demerits over other types of carrier aided distance protection. (04)

d> With a neat schematic diagram and wave forms explain phase comparison carrier current protection. (08)

Q4: a> Discuss the digital technique for removal of DC offset component from current signal. (05)

b> Derive an expression to calculate R and X of line seen by relay using three sample algorithm(Differential Equation Technique). Develop program flowchart for the computation of R and X using the same. (05)

c> How can R and X of the line seen by the relay be calculated using an algorithm based on Discrete Fourier Transform(DFT)? How many computations are required to calculate the same using DFT and many computations are required to calculate the same using Fast Fourier Transform(FFT)? Why is the half cycle data window preferred over full cycle data window for digital distance relay? (10)

Page 1

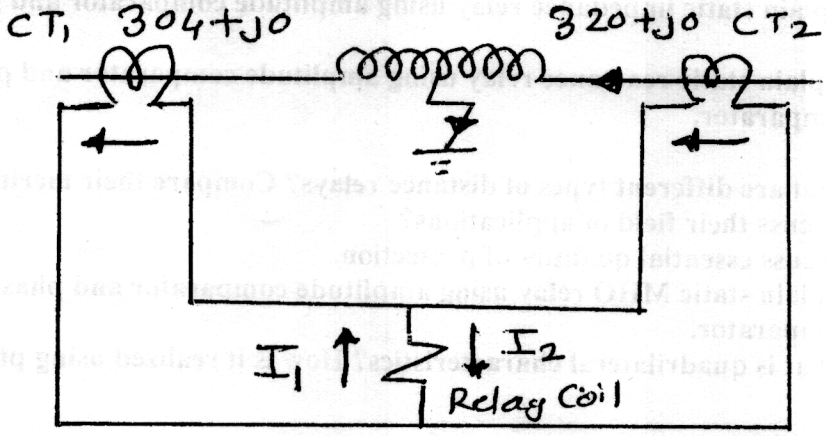
M.E. (E&TC) Sem I Power Electronics & Power Systems.

Protection in Power System 19/11/14

Q5: a> What are different protection schemes normally used for protection of power transformer from internal faults? Discuss one of them in brief with a sketch. (08)

b> A three phase transformer having line voltage ratio 400V/33000V is connected in star delta. The CT on the 400V side have current ratio of 1000/5. What must be the ratio of CT on 33000V side. (04)

c> The figure below shows a differential protection system. The fault current for an earth fault on winding is indicated. The CT ratio is 400/5. The relay is set to operate for current of 0.1 Amp. in its coil. Under the indicated fault, will the relay operate. The relay is without bias. (04)



d> Find real and imaginary parts of fundamental frequency phasor of the signal if its eight samples have values {1, 2, 3, 4, 1, 2, 3, 4}. (04)

Q6: a> Discuss merits and limitations of microprocessor based relays. (04)

b> Discuss only algorithm that can be used by microprocessor to realize directional relay. (04)

c> Realize reactance relay using microprocessor with interfacing diagram, flowchart and code. (12)

Q7: Write detail note on (20)

a> Electromagnetic Relays.

b> SCADA.
