## Conventional Paper-I-2011
## PART-A

**1.a** Give five properties of static magnetic field intensity. What are the different methods by which it can be calculated? Write a Maxwell's equation relating this in integral and differential forms.

**1.b** Explain the following:

i. Poynting vector and its significance

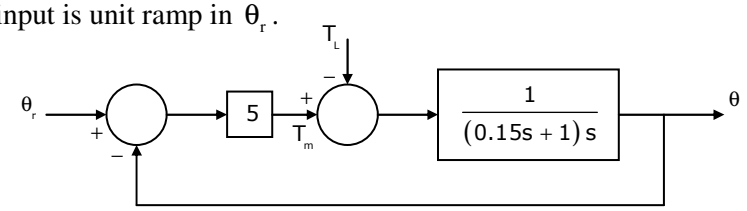
ii. Loss tangent of dielectrics as used in wave propagation

iii. Intrinsic impedance of a wave medium

**1.c** What is a distortionless line? How to achieve distortionless condition on the line? Derive the necessary equations.

**2.a** Show the electrical connection diagram and model the armature voltage controlled dc motor in a block diagram form. Assume the necessary variables and obtain transfer function for change in position of armature to the change in armature voltage. Express the transfer function in standard form.

**2.b** For the system represented by a block diagram shown below, evaluate the closed-loop transfer function. Calculate damping factor, frequency of oscillation (if any), steady-state error if the input is unit ramp in $\theta_r$.



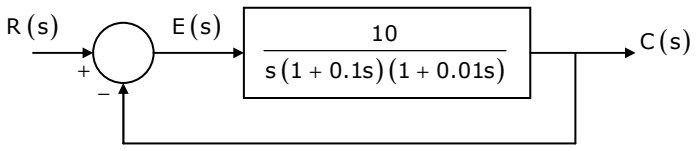

**2.c** i. For a second order system, the location of poles is known to be $-3 \pm j7$. Calculate peak time, % overshoot and approximate settling time for $\pm 2\%$ range.

ii. What are the properties of linear systems not valid for non-linear systems? Explain each briefly.

**3.a.** i. Determine the complete stability information by using Routh criteria for a unity feedback closed system modeled by a plant TF

$$G(s) = \frac{128}{s\left(s^7 + 3s^6 + 10s^5 + 24s^4 + 48s^3 + 96s^2 + 128s + 192\right)}$$

ii. For the system shown in the figure below, draw the Nyquist diagram and determine the margins of stability:



**3.b** i. A system is represented by the following transfer function model:

$$G(s)=\frac{C(s)}{R(s)}=\frac{s+5}{(s+1)(s+2)(s+3)}$$

Obtain the state-space model for this system such that the system matrix is in diagonalized form. The choice of state variables needs to be clearly indicated.

ii. A system is modeled by state space model as:

$$\dot{X}=\begin{bmatrix}-2 & 1\\ 2 & -3\end{bmatrix}X+\begin{bmatrix}1\\ -2\end{bmatrix}u;\ Y=\begin{bmatrix}1 & 0\end{bmatrix}X$$

Evaluate the state transition matrix and the autonomous response of the system with initial condition $x(0)=\begin{bmatrix}1 & 2\end{bmatrix}^T$

**3.c** Draw the schematic diagram of a 2-phase servomotor and draw the torque-speed characteristic. What care is taken to obtain linear characteristic? Derive the linearized transfer function under load condition.

## PART-B

**4.a** Give the properties of superconductors. What are type I and type II superconductors? Indicate their behaviour with respect to applied magnetic field.

**4.b** Explain the Hall Effect in semiconductors and define Hall constant. What do you mean by negative Hall constant?

**4.c** Explain the following:

i. Complex dielectric constant

ii. Ceramics as insulating materials

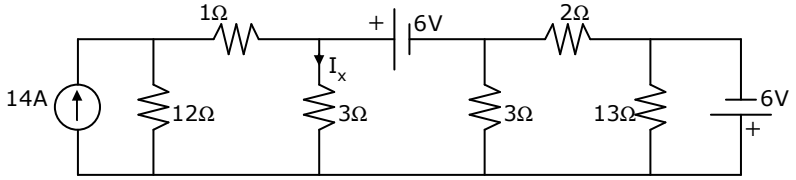
**5.a** Name the basic polarization mechanisms which occur in a dielectric. A dielectric material contains $2\times10^{19}$ polar molecules / $m^3$, each of dipole moment $1.8\times10^{-27}\,C-m$. Assuming that all the dipoles are aligned in the direction of electric field $\vec{E}=10^5\vec{a_x}\,V/m$, find $\vec{P}$ and $\varepsilon_r$

**5.b** With respect to magnetic behaviour, give the classification of magnetic materials. Discuss general electric and magnetic characteristics of ferrites and their applications.

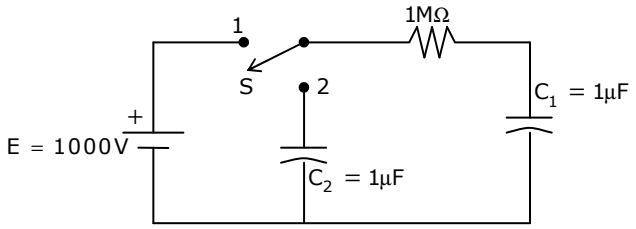
**5.c** Describe in detail the thermal break-down of solid dielectric under application of alternating as well as direct voltages.

## PART-C

**6.a** Find the current $I_x$ which flows through the $3\Omega$ resistor in the circuit of the figure below:




**6.b** In the circuit of the figure below, switch S has been in position-1 for a long time:




i. Find the complete solution for the current in the circuit when S is put to position-2

ii. How long does it take in seconds for the transient to disappear (current to decay within 1%)?

iii. Determine the voltage which appears across each capacitor at steady state.

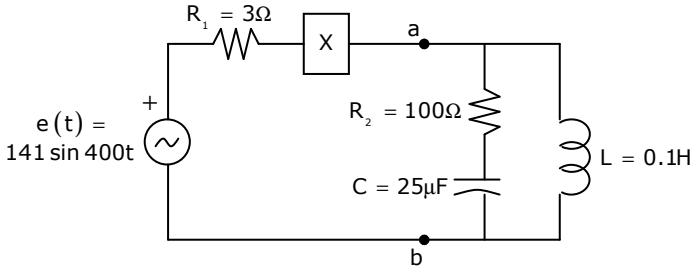
**6.c** A single-phase motor takes 50A at a p.f. of 0.5 lag from a 250V, 50Hz supply. What must be the value of the shunting capacitor to raise the overall p.f. to 0.9 lag? How does the capacitor affect the line and motor currents?

**7.a** A fixed capacitance $(X_C = 20\Omega)$ is placed in parallel with a series combination of resistance $(R = 8\Omega)$ and variable inductance $(X_L$ ohms$)$, having negligible resistance. An alternating voltage of 120V is applied across the parallel combination. Show that the value of $X_L$ which will produce unity power factor resonance is given by:

$$X_L = \frac{X_C}{2} \pm \sqrt{\frac{X_C^{\,2}}{4} - R^2}$$

Determine the minimum value of the current drawn from the supply.

**7.b** A circuit has the configuration depicted in the figure below:



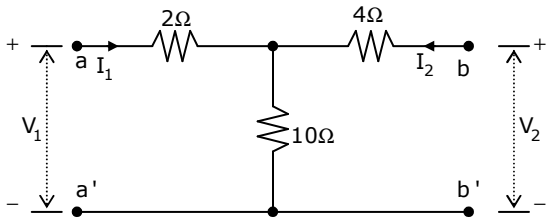
i. Find the equivalent impedance appearing to the right of points ab.

ii. Determine the value of the reactance X which makes the source current in phase with the source voltage.

iii. Should the reactance X of part (ii) be inductive or capacitive? Find the required value of L or C.

iv. Compute the effective value of the source current for the condition described in part (ii).

**7.c** Find ABCD parameters for the two-port network shown in the figure below:



## PART-D

**8.a** Explain, with a diagram, how Wien's bridge can be used for experimental determination of frequency. Derive the expression for frequency in terms of bridge parameters.

**8.b** The power factor of a circuit is determined by $\cos\phi = \frac{P}{VI}$, where P is the power in Watt, V is the voltage in volt and I is the current in ampere. The relative errors in power, current and voltage are respectively $\pm 0.5\%$, $\pm 1\%$ and $\pm 1\%$.

Calculate the relative error in power factor. Also calculate the uncertainty in power factor if the errors were specified as uncertainties.

**8.c** An electric utility supplies power to 1MW load at power factor (p.f.) 0.85 and at 11kV. The utility wants to measure the voltage, current and power factor continuously using 250V voltmeter, 10A ammeter and 250V, 10A power factor meter. Draw circuit diagram of the scheme.

Discuss, why the p.f. meter does not come back to zero reading like voltmeter and ammeter after disconnecting the supply to it.

**9.a** Describe the principle of frequency measurement using digital technique. Draw its block diagram. The unknown input signal of 2V square wave is of 3.5kHz. Determine the display indication if the gate enable time is

(i) 0.1second (ii) 1 second and (iii) 10seconds

**9.b** Suggest a negative temperature coefficient device for the measurement of temperature $[0°C - 150°C]$. Describe the resistance-temperature characteristic, voltage-current characteristic and current-time characteristic of thermistors. Draw a circuit for measurement of temperature using thermistor. The output relation for a thermistor transducer is given by $R = R_0 e^{\beta\left(\frac{1}{T}-\frac{1}{T_0}\right)}$.

For $T_0 = 300K$, $\beta$=3420, $R_0 = 1k\Omega$ and R=2k$\Omega$, calculate T.

**9.c** Draw the line diagram of data acquisition system from process plant to computer system. Explain the function of each component. What do you understand by smart transducer? Discuss it in brief.

**10.a** A parallel-plate capacitor with plate area of $10cm^2$ and plate separation of 6mm has a voltage $50\sin\left(10^3 t\right)$ V applied to its plates. Determine the displacement current, assuming $\varepsilon = 2\varepsilon_0$.

**10.b** State Ampere's circuit law. A hollow conducting cylinder has inner radius a and outer radius b, and carries a current I along the positive z-direction. Find $\vec{H}$ everywhere .

**10.c** For a lossless two-wire transmission line, show that:

i. The phase velocity $u=c=\frac{1}{\sqrt{LC}}$

ii. The characteristic impedance, $Z_0 = \frac{120}{\sqrt{\varepsilon_r}} \cosh^{-1} \frac{d}{2a}$