UG/5th Sem/Elec(H)/T/19

2019

B.Sc. (Honours)

5th Semester Examination

ELECTRONICS

Paper - DSE-2T

(Theory)

Full Marks : 40 Time : 2 Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

(Nano Electronics)

1. Answer any *five* questions from the following : 2×5=10

(i) What do you mean by "top-down" approach and "bottom up" approach ? 1+1

(ii) What is the difference between sputtering and thermal deposition ? 2

[Turn Over]

(iii) What do you mean by quantum confinement effect ? 2

(iv) Draw the density of state-energy diagram for 0D and 1D structure. 1+1

(v) Explain how tapping mode AFM imaging is conducted. 2

(vi) What do you mean by RHEED ? 2

(vii) Give two applications of graphene. 2

(viii) How are the nano particles used in drug delivery ? 2

2. Answer any *four* questions from the following : 5×4=20

(i) Why does energy discreteness occurs in nano materials ? 5

(ii) Given the electron mobility of GaAs is 1.32 $m^2V^{-1}s^{-1}$, the effective mass of an electron is 0.068 m_0 and the mean drift velocity of the electrons is 0.18×10^6 ms^{-1}.

(a) Calculate the mean free distance of electrons between two collisions.

(b) Suggest how ballistic transport can be established in the material. 3+2

(iii) Write a short note on quantum dot laser. 5

(iv) What does limit the minimum feature size (MFS) in optical lithography ? State the general equation that describes the MFS in optical lithography and define all the terms used in the equation. 1+2+2

(v) Describe briefly the idea of AFM. 5

(vi) Give the schematic of SEM instrument and briefly mention its main parts. 2+3

3. Answer any *one* question from the following : 10×1=10

(i) What is coulomb blockade ? How is a coulomb diamond structure used to design a single electron transistor ? 4+6

(ii) What is the operating voltage of TEM ? What are major errors associated with TEM ? Give the sketch diagram of TEM ? What is the basic difference between SEM and TEM. 1+2+4+3

(Transmission Line, Antenna and Wave Propagation)

1. Answer any *five* questions from the following : 2×5=10

(i) Deduce an expression for distortionless transmission line. 2

(ii) A transmission line of characteristic impedance $50\,\Omega$ is terminated by a load impedance $Z_L = 75\Omega$. Find the Return loss of the line. 2

(iii) Draw the impedance profile on a short circuited transmission line.

(iv) Define Maximum Usable Frequency (MUF) in connection with ionospheric propagation. 2

(v) Draw E & H plane radiation pattern of Hertzian dipole. 2

(vi) What are the phase and group velocities of an electromagnetic wave propagating in a medium ? 2

(vii) What is the characteristic impedance of a lossless transmission line ? 2

(viii) Why do we need antenna array ? 2

2. Answer any *four* questions from the following : 5×4=20

(i) Deduce Telegrapher's equation for a two wire transmission line. 5

(ii) Write down integral form of Maxwell's equations. 5

(iii) Define (a) Effective area (b) Directivity (c) Gain (d) Antenna efficiency (e) Half power beam width of an antenna. 5

(iv) A transmission line of characteristic impedance 100Ω is terminated by a load impedance of $Z_L = 40 + j70\Omega$. The line is 0.3λ long.

Find

(a) Input impedance.

(b) Reflection coefficient at load.

(c) VSWR on the line.

You may use Smith chart. 5

(v) Find expressions for characteristic impedance (z_0) and propagation constant (r) of a low loss transmission line. 5

(vi) (a) What is the fundamental mode of a circular waveguide ? Draw is field patterns.

(b) Describe the working principle of a four-port directional coupler. (1+1)+3

3. Answer any *one* question from the following : 10×1=10

(i) (a) Deduce expressions for the Cut-off frequency and phase velocity of a wave propagating inside a rectangular waveguide.

(b) Why TEM mode can not propagate through a rectangular waveguide ? 8+2

[Turn Over]

(ii) (a) Assuming that a metallic rectangular waveguide whose cross-section is a×b such that a>b and it supports TE^z mode of propagation (all terms are carrying their usual meaning). The field components can be expressed for TE^z mode as : 7

$$E_x = -\frac{1}{\varepsilon}\frac{\partial \psi_e}{\partial y} \qquad H_x = \frac{1}{j\omega\mu\varepsilon}\frac{\partial^2 \psi_e}{\partial x \partial z}$$

$$E_y = -\frac{1}{\varepsilon}\frac{\partial \psi_e}{\partial x} \qquad H_y = \frac{1}{j\omega\mu\varepsilon}\frac{\partial^2 \psi_e}{\partial y \partial z}$$

$$E_z = 0 \qquad H_z = \frac{1}{j\omega\mu\varepsilon}\left(\frac{\partial^2}{\partial z^2} + K^2\right)\psi_e$$

(A) Find the eigenfunction $\psi_e(x, y, z)$

(B) Find the expression for computing resonant frequency from wave equation.

(C) Determine the fundamental mode for TE^z mode.

(D) Draw the field patterns for TE_{21}^{z} and TE_{32}^{z} modes.

(b) What is the physical significance of the evanescent mode ? Give suitable example. 2

(c) How can we excite TE_{11}^{z} mode in rectangular waveguide ? 1

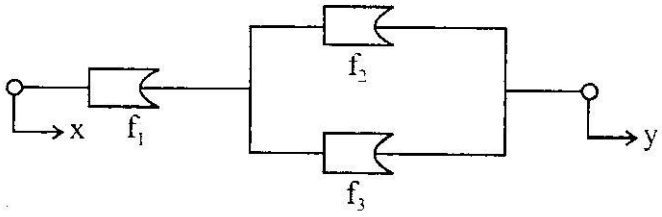
[Turn Over]

(Control System)

1. Answer any *five* questions from the following : $2\times5=10$

(i) Compare the bandwidths of two systems having transfer function as follows $G_1(s) = \frac{1}{1+2s}$ and $G_2(s) = \frac{1}{1+5s}$. Justify your answer. 2

(ii) Obtain the equivalent viscous friction coefficient of the following circuit. 2



(iii) The open-loop DC gain of a unity negative feedback control system with closed loop transfer function $\frac{S+4}{S^2+7S+13}$ is (a) $\frac{4}{13}$ (b) $\frac{4}{9}$ (c) 4 (d) 13.

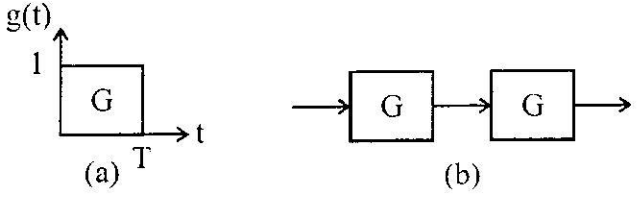
(iv) Determine the gain and phase margin of an all pass system (one first order pole and one first order zero). 1+1

(v) "All the steady state errors are positional in nature".—Explain. 2

(vi) The open loop transfer function of a unity feedback control system is given by $G(S) = e^{-ST} / S(S+2)$. Find the value of T at which $w_g = w_p$. 2

(vii) Define (a) servomechanism (b) state of a system. 1+1

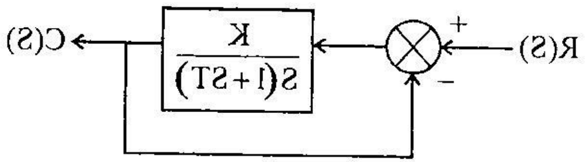
(viii) The impulse response g(t) of a system G, is as shown in figure below (a). What is the maximum magnitude attained by the impulse response of two cascaded blocks of G as shown in (b) ? 2



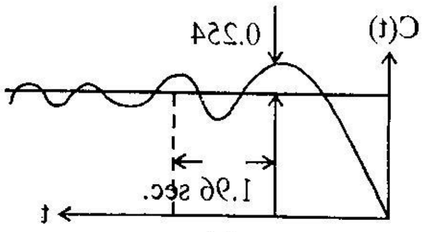
[Turn Over]

2. Answer any *four* questions from the following : $5\times4=20$

(i) The block diagram of a unity feedback control system is as shown in the figure (a) below, subjected to an unit step input, results in a response as shown below (b). Determine the values of K and T from the response curve. Determine the settling time and the time at which third undershoot occurs. Hence, obtain the steady state error when the system is subjected to unit ramp input.



(a)



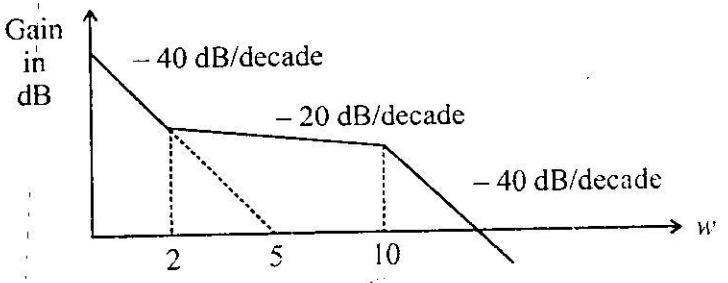
(b)

(ii) An unity feedback control system is represented by the transfer function given below.

$$\frac{Y(s)}{U(s)} = \frac{(S+5)}{(S+2)(S+3)}$$

Determine the state transfer matrix and zero state response for $U(S) = \frac{1}{S}$. Hence, draw the state block diagram using parallel decomposition method. 2+2+1

(iii) Determine the transfer function of the unity feedback control system as shown in the figure below. Hence, find phase margin of the system. Comments on the stability of the system. 2+2+1



(iv) (a) Consider a LTI system with transfer function $H(S) = \frac{1}{S+1}$. If the input is Cos t and the steady state output is A Cos $(t+\alpha)$, then find the value of A & α. 1+1

[Turn Over]

(b) Derive the transfer function relating the angular velocity of the shaft and the applied torque of a rotational inertia damper system. Hence, draw the mechanical circuit diagram of the system. 2+1

(v) The open loop transfer function of a servo system with unity feedback is given by

$$G(s) = \frac{10}{(s+2)(s+5)}$$

Determine the damping ratio, undamped natural frequency of oscillation. What is the percentage overshoot of the response to a unit step input ? 1+2+2

(vi) Sketch the Bode plot for the transfer function given below

$$G(s) = \frac{1000}{(1+0.1s)(1+.001s)}$$ 5

3. Answer any *one* question from the following : 10×1=10

(i) (a) Draw the circuit diagram of a PID controller in series mode using OP-AMPs and derive its transfer function. Hence, obtain the derivative and integral time. 2+2+1+1

(b) Write down some advantages and limitations of phase-lag network. 2

(c) State and explain Nyquist stability criterion. 2

(ii) (a) Compare open-loop and closed loop systems. 2

(b) The open-loop transfer function of a feedback control system is given by

$$G(s)H(s) = K/s(s+10).$$

Find the value of gain factor K for critical damping. 2

(c) A unity feedback control system has an open loop transfer function

$$G(s) = K/s(s^2+7s+12).$$

Now, find the value of K for which $s = -1 \neq j1$ will lie on the root-locus of the system. 2

[Turn Over]

(d) The overall transfer function of a unity feedback control system is given by

$$C(s)/R(s) = \frac{10}{s^2} + 6s + 10 .$$

Find the type and order of the system. 1+1

(e) Determine the transfer function $\frac{Y(s)}{X_2(s)}$ of a system represented by the following SFG 2