TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BEI, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electro-magnetics *(EX 503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *<u>Necessary formula sheet are attached herewith.</u>*
- ✓ $\vec{A}$ represent a vector and $\vec{a}_{subscript}$ denotes a unit vector along the direction given by the subscript.
- ✓ *Assume suitable data if necessary.*

1. Transform the vector $\vec{F}$ into the cylindrical co-ordinate system.
$\vec{F} = 10\vec{a_x} - 8\vec{a_y} + 6\vec{a_z}$ at point $P(x = 10, y = -8, z = 6)$ [5]

2. Define electric dipole moment. Two uniform line charges, 8 nC/m each, are located at $x = 1, z = 2$ and at $x = -1, y = 2$ in free space. If the potential at the origin is 100 V, find V at P(4, 1, 3). [2+6]

3. State Gauss's Law. The region $y < 0$ contains a dielectric material for which $\varepsilon_{r1} = 2.5$, while the region $y > 0$ is characterized by $\varepsilon_{r2} = 4$. Let $\vec{E_1} = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z$ V/m, find the electric field intensities, flux densities in region 2 and the angle θ_1, which is the angle made by normal component of $\vec{E}$ or $\vec{D}$ with total $\vec{E}$ or $\vec{D}$. [2+3+2+1]

4. Derive Poisson's equation. Assuming that the potential V in the cylindrical coordinate system is the function of ρ only, solve the Laplacian equation by integration method and derive the expression for the capacitance of co-axial capacitor using the same solution of V. [2+5]

5. State Stoke's theorem. Evaluate both sides of Stroke's theorem for the field
$\vec{H} = 8xy\hat{a}_x - 5y^2\hat{a}_y A/m$ and the rectangular path around the region $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Let the positive direction of $\vec{dS}$ be $\hat{a}_z$. [1+7]

6. Define Ampere's Circuital law. Determine H at $P_2(0.4, 0.3, 0)$ in the field of an 8 A filamentary current directed inward from infinity to the origin on the positive x axis, and then outward to infinity along the y axis. [2+6]

7. Explain motional induction with necessary derivations. Correct the equation $\nabla \times \vec{H} = \vec{J}$ with necessary arguments and derivation for time varying fields. [3+4]

8. Derive the expression for electric and magnetic fields for a uniform plane wave propagating in a dissipative medium. [4+3]

9. A uniform plane wave in free space is given by $\vec{H_S} = (250\angle 30^\circ)e^{-j350Z}\hat{a}_x$ V/m. Determine phase constant, frequency of the wave, intrinsic impedance, $\vec{E_S}$ at $z = 25$ mm and $t = 4$ps. [1+2+1+2]

10. Define the secondary parameters of a transmission line. A lossless transmission line with $Z_o = 50$ ohm has a length of 0.4λ. The operating frequency is 300 MHz and it is terminated with a load $Z_L = 40 + j30$. Find: [2+1+2+3]
    a) Reflection Coefficient
    b) Standing wave ratio on the line (SWR)
    c) Input impedance (Zin)

11. Differentiate between TE and TM modes. Consider a rectangular waveguide with $\varepsilon_r = 4$, $\mu = \mu_0$ with dimensions $a = 2.08$ cm, $b = 0.54$ cm. Find the cutoff frequency for TM_{11} mode and the dominant mode. [3+3]

12. Write short note on antenna and its types. [2]

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Divergence

$$\text{Cartesian}: \nabla\cdot\bar{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$$

$$\text{Cylindrical}: \nabla\cdot\bar{D} = \frac{1}{\rho}\frac{\partial(\rho D_\rho)}{\partial\rho} + \frac{1}{\rho}\frac{\partial D_\phi}{\partial\phi} + \frac{\partial D_z}{\partial z}$$

$$\text{Sphecrical}: \nabla\cdot\bar{D} = \frac{1}{r^2}\frac{\partial(r^2 D_r)}{\partial r} + \frac{1}{r\sin\theta}\frac{\partial(D_\theta\sin\theta)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial\phi}$$

Gradient

$$\text{Cartesian}: \nabla V = \frac{\partial V}{\partial x}\hat{a}_x + \frac{\partial V}{\partial y}\hat{a}_y + \frac{\partial V}{\partial z}\hat{a}_z$$

$$\text{Cylindrical}: \nabla V = \frac{\partial V}{\partial\rho}\hat{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial\phi}\hat{a}_\phi + \frac{\partial V}{\partial z}\hat{a}_z$$

$$\text{Spherical}: \nabla V = \frac{\partial V}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial V}{\partial\theta}\hat{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi}\hat{a}_\phi$$

Curl

$$\text{Cartesian}: \nabla\times\bar{H} = \left(\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}\right)\hat{a}_x + \left(\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right)\hat{a}_y + \left(\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right)\hat{a}_z$$

$$\text{Cylindrical}: \nabla\times\bar{H} = \left(\frac{1}{\rho}\frac{\partial H_z}{\partial\phi} - \frac{\partial H_\phi}{\partial z}\right)\hat{a}_\rho + \left(\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial\rho}\right)\hat{a}_\phi + \frac{1}{\rho}\left(\frac{\partial(\rho H_\phi)}{\partial\rho} - \frac{\partial H_\rho}{\partial\phi}\right)\hat{a}_z$$

$$\text{Spherical}: \nabla\times\bar{H} = \frac{1}{r\sin\theta}\left(\frac{\partial(H_\phi\sin\theta)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}\right)\hat{a}_r + \frac{1}{r}\left(\frac{1}{r\sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial(rH_\phi)}{\partial r}\right)\hat{a}_\theta + \frac{1}{r}\left(\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial\theta}\right)\hat{a}_\phi$$

Laplacian:

$$\text{Cartesian}: \nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

$$\text{Cylindrical}: \nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial V}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial\phi^2} + \frac{\partial^2 V}{\partial z^2}$$

$$\text{Spherical}: \nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial V}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial\phi^2}$$

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2079 Baishakh

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Subject: - Electromagnetics (*EX 503*)

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1. Express the vector field A = (x-y) a_y in cylindrical and spherical coordinate systems. [5]
2. Find the total charge inside the volume indicated: [4]

   $\rho_v = 4xyz^2, 0 \le \rho \le 2, 0 \le \phi \le \frac{\pi}{2}, 0 \le z \le 3.$
3. Obtain the equation of the streamline that passes through the point P (-2,7,10) in the field: [4]

   $\bar{E} = 2(y-1)\hat{a}_x + 2x\,\hat{a}_y.$
4. Given the potential field in cylindrical coordinates, $V = [100/(z^2+1)]\rho\cos\phi V$, and point P at $\rho = 3$ m, $\phi = 60°$, $z = 2$ m, find values at P for (a) V; (b) E; (c) **E**; (d) dV/dN; (e) a_N; (f) ρ_v in free space. [6]
5. Define gradient and laplacian function. A point charge of 16nC is located at Q (2,3,5) in free space and a uniform line charge of 5nC/m is at the intersection of the plane x=2 and y=4. If the potential at the origin is 100V, Find V at P (4,1,3). [2+6]
6. Define curl and its significance in Electromagnetics. Evaluate both sides of stokes theorem for the field H=6xy a_x - 3y^2 a_y A/m and the rectangular path around the region $2 \le x \le 5, -1 \le y \le 1, z = 0$, let the positive direction of ds be a_z. [2+6]
7. Justify the Maxwell's equation: $\oint_S \vec{B}.\vec{dS} = 0$ with necessary remarks. Derive an expression of magnetic field intensity for an infinite filament carrying a direct current using vector magnetic potential. [2+6]
8. Write down the Maxwell equation in phasor form. Derive the equation for electric field for a uniform plane wave travelling in air. [2+6]
9. A uniform plane wave in free space in given by Electric field intensity $\vec{E}$ in phasor form as:

   $\vec{E}_s = 200\angle 30° e^{-j250z}\,\hat{a}_x$ V/m Find:

   a) Angular frequency (ω)

   b) Wavelength (λ) and intrinsic impedance (η)

   c) Magnetic field intensity $\vec{H}(x,y,z,t)$ at z = 8 mm and t = 6pS. [2+2+4]

10. Define Faraday's law. A conductor with cross-sectional area of 10 cm^2 carries conduction current $\vec{J} = 0.2 \sin 10^9 t\, \hat{a}_z$ mA. Given that $\sigma = 2.5 \times 10^6$ S/m, and $\varepsilon_r = 6$. Calculate the value of the displacement current. [2+4]

11. A lossless transmission line is 80 cm long and operates at a frequency of 600 MHz. The line parameters are L= 0.25 μH/m and C = 100pF/m. Find the characteristic impedance, the phase constant, the phase velocity on the line, and the input impedance for Z_L=100Ω. [8]

12. Define dominant mode. A standard air-filled rectangular waveguide with dimensions 8.636 cm × 4.318 cm is fed by a 8 GHz carrier from a coaxial cable. Determine if a TE_{10} mode will be propagating or not. [1+4]

13. Write short notes on antenna and its parameters. [2]

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2078 Bhadra

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1. Given a point P (-2, 6, 3) and vector field $\vec{A} = y\vec{a}_x + (xy+z)\vec{a}_y$, express P and $\vec{A}$ in spherical co-ordinate system. [5]

2. A point charge of 6μc located at origin, uniform line charge density of 180nc/m lies along x-axis and uniform sheet charge of 25 c/m^2 lies on z = 0 plane. Find $\vec{D}$ at point (1, 2, 4). [7]

3. Derive the expression for an electric field intensity due to an infinitely long line charge with charge density ρ_L by using Gauss's law. Find the volume charge density that is associated with the field $\vec{D} = xy^2\vec{a}_x + x^2y\vec{a}_y + z\vec{a}_z\ C/m^2$. [4+3]

4. State continuity equation. Given the vector current density $\vec{J} = 10\rho^2 z\vec{a}_\rho - 4\rho\sin^2\phi\vec{a}_\phi$ mA/m^2. Determine the current following outward the circular band $\rho = 5$, $0 < \phi < 2\pi$, $2 < z < 2.8$. [2+4]

5. Differentiate between scalar magnetic potential and vector magnetic potential. If a vector magnetic potential is $\vec{A} = -(\rho^2/4)\vec{a}_z$wb/m, calculate total magnetic flux crossing the surface $\phi = \pi/2$, $1 \le \rho \le 2$ m and $0 \le z \le 5$ m. [4+4]

6. The region y < 0 (region 1) is air and y > 0 (region 2) has $\mu_r = 10$. If there is a uniform magnetic field $\vec{H} = 5\hat{a}_x + 6\hat{a}_y + 7\hat{a}_z$ A/m in region 1, find $\vec{B}$ and $\vec{H}$ in region 2. [8]

7. Correct the equation $\nabla \times \vec{E} = 0$ for time varying field with necessary derivation. Also modify the equation $\nabla \times \vec{H} = \sigma\vec{E}$ with necessary arguments and derivation for time varying field. [3+4]

8. A uniform plane wave in free space is given by $\vec{H}_S = (250\angle 30°)e^{-j350Z}\vec{a}_x\ V/m$. Determine phase constant, frequency of the wave, intrinsic impedance, $\vec{E}_S$ and the magnitude $\vec{H}$ of at z = 25 mm and t = 4ps. [1+1+2+2+2]

9. Derive the expression for electric and magnetic fields for a uniform plane wave propagating in a free space. [8]

10. A lossless transmission line is 80 cm long and operates at a frequency 1 GHz. The line parameters are L = 0.5 μH/m and C = 200 pF/m. Find the characteristics impedance, the phase constant, the velocity on the line, and the input impedance for $Z_L = 100\Omega$. [2+2+2+2]

11. Write short notes on TE and TM modes of rectangular waveguide. An air filled rectangular waveguide has cross-section of 2.3 cm × 1.02 cm. Calculate the cutoff frequency of the dominant mode (TE_{10}). [3+3]

12. Write short notes about antenna and its parameters. [2]

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Divergence

$$\text{Cartesian}: \nabla\cdot\bar{D}=\frac{\partial D_x}{\partial x}+\frac{\partial D_y}{\partial y}+\frac{\partial D_z}{\partial z}$$

$$\text{Cylindrical}: \nabla\cdot\bar{D}=\frac{1}{\rho}\frac{\partial(\rho D_\rho)}{\partial\rho}+\frac{1}{\rho}\frac{\partial D_\phi}{\partial\phi}+\frac{\partial D_z}{\partial z}$$

$$\text{Sphecrical}: \nabla\cdot\bar{D}=\frac{1}{r^2}\frac{\partial(r^2 D_r)}{\partial r}+\frac{1}{r\sin\theta}\frac{\partial(D_\theta\sin\theta)}{\partial\theta}+\frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial\phi}$$

Gradient

$$\text{Cartesian}: \nabla V=\frac{\partial V}{\partial x}\hat{a}_x+\frac{\partial V}{\partial y}\hat{a}_y+\frac{\partial V}{\partial z}\hat{a}_z$$

$$\text{Cylindrical}: \nabla V=\frac{\partial V}{\partial\rho}\hat{a}_\rho+\frac{1}{\rho}\frac{\partial V}{\partial\phi}\hat{a}_\phi+\frac{\partial V}{\partial z}\hat{a}_z$$

$$\text{Spherical}: \nabla V=\frac{\partial V}{\partial r}\hat{a}_r+\frac{1}{r}\frac{\partial V}{\partial\theta}\hat{a}_\theta+\frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi}\hat{a}_\phi$$

Curl

$$\text{Cartesian}: \nabla\times\bar{H}=\left(\frac{\partial H_z}{\partial y}-\frac{\partial H_y}{\partial z}\right)\hat{a}_x+\left(\frac{\partial H_x}{\partial z}-\frac{\partial H_z}{\partial x}\right)\hat{a}_y+\left(\frac{\partial H_y}{\partial x}-\frac{\partial H_x}{\partial y}\right)\hat{a}_z$$

$$\text{Cylindrical}: \nabla\times\bar{H}=\left(\frac{1}{\rho}\frac{\partial H_z}{\partial\phi}-\frac{\partial H_\phi}{\partial z}\right)\hat{a}_\rho+\left(\frac{\partial H_\rho}{\partial z}-\frac{\partial H_z}{\partial\rho}\right)\hat{a}_\phi+\frac{1}{\rho}\left(\frac{\partial(\rho H_\phi}{\partial\rho}-\frac{\partial H_\rho}{\partial\phi}\right)\hat{a}_z$$

$$\text{Spherical}: \nabla\times\bar{H}=\frac{1}{r\sin\theta}\left(\frac{\partial(H_\phi\sin\theta)}{\partial\theta}-\frac{\partial H_\theta}{\partial\phi}\right)\hat{a}_r+\frac{1}{r}\left(\frac{1}{r\sin\theta}\frac{\partial H_r}{\partial\phi}-\frac{\partial(rH_\phi)}{\partial r}\right)\hat{a}_\theta+\frac{1}{r}\left(\frac{\partial(rH_\theta}{\partial r}-\frac{\partial H_r}{\partial\theta}\right)\hat{a}_\phi$$

Laplacian:

$$\text{Cartesian: } \nabla^2 V=\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}+\frac{\partial^2 V}{\partial z^2}$$

$$\text{Cylindrical: } \nabla^2 V=\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial V}{\partial\rho}\right)+\frac{1}{\rho^2}\frac{\partial^2 V}{\partial\phi^2}+\frac{\partial^2 V}{\partial z^2}$$

$$\text{Spherical: } \nabla^2 V=\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right)+\frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial V}{\partial\theta}\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial\phi^2}$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2078 Kartik

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Subject: - Electromagnetics *(EX 503)*

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- ✓ $\vec{A}$ represent a vector and $\vec{a}_{subscript}$ denotes a unit vector along the direction given by the subscript.
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1. Transform a vector field $\vec{A} = 4\vec{a_x} - 2\vec{a_y} - 4\vec{a_z}$ into cylindrical coordinate system at a point P (2, 3, 5). [5]

2. A plane x = 2 carry a surface charge density 10 nC/m^2, a line x = 0 and z = 3 carry a line charge density 10 nC/m and a point charge of 10nC is at origin. Calculate $\vec{E}$ at (1, 1, -1) due to these charge configurations. [7]

3. Evaluate the both sides of divergence theorem for the field $\vec{D} = 2xy\vec{a}_x + x^2\vec{a}_y C/m^2$ and the rectangular parallelopiped formed by the planes x = 0 and 1, y = 0 and 2, and z = 0 and 3. [7]

4. If potential field in free space is $V = \frac{10}{r^2}\sin\theta\cos\phi$ V and point P is located at (2, 90°, 0°). Find: (a) $\vec{E}$ (b) direction of $\vec{E}$ at P (c) energy density at P. [2+2+2]

5. Find the vector magnetic field intensity $\vec{H}$ in Cartesian coordinates at P (2, 1, 3) caused filament of 12 Ampere(A) in a $\vec{a_z}$ direction on the z-axis and extending from z = 0 to z = 4. [8]

6. Consider a boundary at z = 0 which carries current $\vec{K} = \left(\frac{1}{\mu_0}\right)\vec{a_y}$ mAm. Medium 1 (z < 0) is filled with material whose $\mu_r = 6$ and medium 2 (z > 0) is filled with material whose $\mu_r = 4$. If $\vec{B_2} = 5\vec{a_x} + 8\vec{a_z}$ mT, find $\vec{B_1}$. [8]

7. Define Poynting vector. Using this deduce the time average power density for a dissipative medium. [2+5]

8. A uniform plane wave has a magnetic field component $\vec{H} = 15\cos(2\times10^8 t + \beta x)\vec{a_y}$ A/m in a medium characterized by $\sigma = 0$, $\varepsilon = 4\varepsilon_0$, $\mu = \mu_0$. Find [5+1+2]
   a) direction of propagation, phase constant β, wavelength λ, velocity v_p, intrinsic impedance η
   b) Magnitude of $\vec{H}$
   c) $\vec{E}$

9. A uniform plane wave in air partially reflects from the surface of a material whose properties are unknown. Measurements of the electric field in the region in front of the interface yield a 1.5 m spacing between maxima, with the first maximum occurring 0.75 m from the interface. A standing wave ratio (SWR) of 5 is measured. Determine the intrinsic impedance of the unknown material. [8]

10. A 50 Ω lossless transmission line is 0.4 λ long. The line is terminated with a load $Z_L = 40 + j30\ \Omega$. If the operating frequency is 300 MHz, find [2+2+4]
   a) reflection coefficient (Γ)
   b) standing wave ratio (s) and
   c) input impedance (Z_{in})

11. Explain why TEM wave doesn't exist in a rectangular waveguide? A rectangular waveguide has dimensions a = 1 cm, b = 2 cm. The medium within the waveguides has $\varepsilon_r = 1$, $\mu_r = 1$, $\sigma = 1$. Find whether or not the signal with the frequency of 500 MHz will be transmitted in the $TE_{1,0}$ mode. [2+4]

12. What are the parameters of antenna? List out the different types of antenna you have studied. [1+1]

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Divergence

Cartesian : $\nabla\cdot\bar{D} = \dfrac{\partial D_x}{\partial x} + \dfrac{\partial D_y}{\partial y} + \dfrac{\partial D_z}{\partial z}$

Cylindrical : $\nabla\cdot\bar{D} = \dfrac{1}{\rho}\dfrac{\partial(\rho D_\rho)}{\partial\rho} + \dfrac{1}{\rho}\dfrac{\partial D_\phi}{\partial\phi} + \dfrac{\partial D_z}{\partial z}$

Sphecrical : $\nabla\cdot\bar{D} = \dfrac{1}{r^2}\dfrac{\partial(r^2 D_r)}{\partial r} + \dfrac{1}{r\sin\theta}\dfrac{\partial(D_\theta\sin\theta)}{\partial\theta} + \dfrac{1}{r\sin\theta}\dfrac{\partial D_\phi}{\partial\phi}$

Gradient

Cartesian : $\nabla V = \dfrac{\partial V}{\partial x}\hat{a}_x + \dfrac{\partial V}{\partial y}\hat{a}_y + \dfrac{\partial V}{\partial z}\hat{a}_z$

Cylindrical : $\nabla V = \dfrac{\partial V}{\partial\rho}\hat{a}_\rho + \dfrac{1}{\rho}\dfrac{\partial V}{\partial\phi}\hat{a}_\phi + \dfrac{\partial V}{\partial z}\hat{a}_z$

Spherical : $\nabla V = \dfrac{\partial V}{\partial r}\hat{a}_r + \dfrac{1}{r}\dfrac{\partial V}{\partial\theta}\hat{a}_\theta + \dfrac{1}{r\sin\theta}\dfrac{\partial V}{\partial\phi}\hat{a}_\phi$

Curl

Cartesian : $\nabla\times\bar{H} = \left(\dfrac{\partial H_z}{\partial y} - \dfrac{\partial H_y}{\partial z}\right)\hat{a}_x + \left(\dfrac{\partial H_x}{\partial z} - \dfrac{\partial H_z}{\partial x}\right)\hat{a}_y + \left(\dfrac{\partial H_y}{\partial x} - \dfrac{\partial H_x}{\partial y}\right)\hat{a}_z$

Cylindrical : $\nabla\times\bar{H} = \left(\dfrac{1}{\rho}\dfrac{\partial H_z}{\partial\phi} - \dfrac{\partial H_\phi}{\partial z}\right)\hat{a}_\rho + \left(\dfrac{\partial H_\rho}{\partial z} - \dfrac{\partial H_z}{\partial\rho}\right)\hat{a}_\phi + \dfrac{1}{\rho}\left(\dfrac{\partial(\rho H_\phi)}{\partial\rho} - \dfrac{\partial H_\rho}{\partial\phi}\right)\hat{a}_z$

Spherical : $\nabla\times\bar{H} = \dfrac{1}{r\sin\theta}\left(\dfrac{\partial(H_\phi\sin\theta)}{\partial\theta} - \dfrac{\partial H_\theta}{\partial\phi}\right)\hat{a}_r + \dfrac{1}{r}\left(\dfrac{1}{r\sin\theta}\dfrac{\partial H_r}{\partial\phi} - \dfrac{\partial(rH_\phi)}{\partial r}\right)\hat{a}_\theta + \dfrac{1}{r}\left(\dfrac{\partial(rH_\theta}{\partial r} - \dfrac{\partial H_r}{\partial\theta}\right)\hat{a}_\phi$

Laplacian:

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Cylindrical: $\nabla^2 V = \dfrac{1}{\rho}\dfrac{\partial}{\partial\rho}\left(\rho\dfrac{\partial V}{\partial\rho}\right) + \dfrac{1}{\rho^2}\dfrac{\partial^2 V}{\partial\phi^2} + \dfrac{\partial^2 V}{\partial z^2}$

Spherical: $\nabla^2 V = \dfrac{1}{r^2}\dfrac{\partial}{\partial r}\left(r^2\dfrac{\partial V}{\partial r}\right) + \dfrac{1}{r^2\sin\theta}\dfrac{\partial}{\partial\theta}\left(\sin\theta\dfrac{\partial V}{\partial\theta}\right) + \dfrac{1}{r^2\sin^2\theta}\dfrac{\partial^2 V}{\partial\phi^2}$

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1. Transform the vector $\vec{A} = 4\hat{a}_x - 2\hat{a}_y - 4\hat{a}_z$ into spherical co-ordinates at a point P(x = -2, y = -3, z = 4). [5]
2. An infinite uniform line charge ρL = 2nC/m lies along the x-axis in free space, while point charges of 8nC each are located at (0, 0, 1) and (0, 0, -1). (a) Find $\vec{D}$ at (2, 3, -4). [6]
3. Define uniqueness theorem. Find the energy stored in free space for the region 2mm< r< 3mm, 0<θ<90°, 0<ϕ<90°, given the potential field V = : [2+6]

   a) $\frac{200}{r}$V and b) $\frac{300}{r^2}\cos\theta$V
4. Using the continuity equation elaborate the concept of Relaxation Time Constant (RTC) with necessary derivations. Let $\vec{J} = \frac{e^{-10^4 t}}{\rho^2}\hat{a}_\rho$ A/m^2 be the current density in a given region. At t = 10ms, calculate the amount of current passing through surface ρ = 2m, $0 \le z \le 3$m, $0 \le \phi \le 2\pi$. [4+4]
5. State and prove the Stoke's Theorem. Calculate the value of the vector current density: In cylindrical coordinates at $P_B(1.5, 90°, 0.5)$ if $\vec{H} = \frac{2}{\rho}(\cos 0.2\,\phi)\,\hat{a}_\rho$. [5+3]
6. Define scalar magnetic potential. The region y<0 (region 1) is air and y>0 (region 2) has $\mu_r = 10$. If there is a uniform magnetic field $\vec{H} = 5\hat{a}_x + 6\hat{a}_y + 7\hat{a}_z$ A/m in region 2, find $\vec{B}$ and $\vec{H}$ in region 2. [2+6]
7. List out the Maxwell equations phasor form for time varying case in free space. A conducting bar can slide freely over two conducting rails placed at x = 0 and x = 10cm. Calculate the induced voltage in the bar if the bar slides at a velocity $\vec{V} = 10\hat{a}_y$ m/s and $\vec{B} = 3\hat{a}_z \text{mWb/m}^2$. [2+3]

8. A uniform plane wave in free space is given by $\vec{H_S} = (250\angle 30^\circ)e^{-j350Z}\hat{a}_x \, V/m$. Determine phase constant, frequency of the wave, intrinsic impedance, $\vec{E_S}$ and the magnitude $\vec{H}$ of at $z = 25mm$ and $t = 4ps$. [1+2+1+2+2]

9. Within a certain region, $\varepsilon = 10^{-11} F/m$ and $\mu = 10^{-5} H/m$. If $B_x = 2\times10^{-4} \cos 10^5 t \sin 10^{-3} y$ T find: [3+3+2]

   a) Find $\vec{E}$
   b) Find the total magnetic flux passing through the surface x = 0, 0 < y < 40m, 0 < z < 2m at t = 1 μs
   c) Find the value of the closed line integral of $\vec{E}$ around the perimeter of the given surface.

10. A transmission line operating at 120MHz has R = 20Ω/m, L = 0.3μH/m, C = 63pF/m and G = 4.2ms/m. Find [3+3+2]

    a) Propagation coefficient (γ)
    b) Velocity of wave propagation on the line (v)
    c) Characteristic impedance (Z_o)

11. A rectangular waveguide has dimension a = 4cm and b = 2 cm. Determine the cut-off frequency and range of frequencies over with the guide will operate single mode. [6]

12. Write short notes on antenna and its types. [2]

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX 503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary charts and codes are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Given points A ($\rho = 5, \varphi = 70^{o}, z = -3$) and B ($\rho = 2, \varphi = -30^{o}, z = 1$), find: (a) a unit vector in cartesian coordinates at A directed toward B; (b) a unit vector in cylindrical coordinates at A directed toward B. [5]

2. Two uniform line charges, each 20 nC/m, are located at $y = 1, z = \pm 1$ m. Find the total electric flux leaving the surface of a sphere having a radius of 2 m, if it is centered at A (3, 1, 0). [6]

3. Derive Energy Density in electrostatic field. [7]

4. The conducting planes $2x + 3y = 12$ and $2x + 3y = 18$ are at potentials of 100 V and 0, respectively. Let $\varepsilon = \varepsilon_0$ and find: a) V at P (5, 2, 6); b) E at P(5,2,6). [7]

5. Let a filamentary current of 5 mA be directed from infinity to the origin on the positive z axis and then back out to infinity on the positive x axis. Find H at P (0, 1, 0). [8]

6. State Ampere's circuital law. Let the permittivity be 5 μH/m in region A where $x < 0$, and 20 μH/m in region B where $x > 0$. If there is a surface current density $K = 150a_y - 200a_z$ A/m at $x = 0$, and if $H_A = 300a_x - 400a_y + 500a_z$ A/m, find: (a) $|H_{LA}|$; (b) $|H_{NA}|$; (c) $|H_{LB}|$; (d) $|H_{NB}|$. [10]

7. State and explain the Maxwell's equation in differential and integral form. Also define the displacement current and depth of penetration. [10]

8. Establish the relation for Helmholtz's equation for electromagnetic wave propagation. [5]

9. State and prove Poynting's theorem. [6]

10. A load $Z_l = 80 + j100\Omega$ is located at $z = 0$ on a lossless 50-Ω line. The operating frequency is 200 MHz and the wavelength on the line is 2 m. (a) If the line is 0.8 m in length, use the Smith chart to find the input impedance. (b) What is s? (c) What is the distance from the load to the nearest voltage maximum? [7]

11. An air-filled rectangular waveguide has dimensions a = 2 cm and b = 1 cm. Determine the range of frequencies over which the guide will operate single mode (TE_{10}). [3]

12. Write short notes on: [3x2]
    a) TE mode and TM mode
    b) Antenna Properties

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DIVERGENCE

CARTESIAN $\nabla \cdot \mathbf{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$

CYLINDRICAL $\nabla \cdot \mathbf{D} = \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho D_\rho) + \frac{1}{\rho}\frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$

SPHERICAL $\nabla \cdot \mathbf{D} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 D_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(D_\theta \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial \phi}$

GRADIENT

CARTESIAN $\nabla V = \frac{\partial V}{\partial x}\mathbf{a}_x + \frac{\partial V}{\partial y}\mathbf{a}_y + \frac{\partial V}{\partial z}\mathbf{a}_z$

CYLINDRICAL $\nabla V = \frac{\partial V}{\partial \rho}\mathbf{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi + \frac{\partial V}{\partial z}\mathbf{a}_z$

SPHERICAL $\nabla V = \frac{\partial V}{\partial r}\mathbf{a}_r + \frac{1}{r}\frac{\partial V}{\partial \theta}\mathbf{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi$

CURL

CARTESIAN $\nabla \times \mathbf{H} = \left(\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}\right)\mathbf{a}_x + \left(\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right)\mathbf{a}_y + \left(\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right)\mathbf{a}_z$

CYLINDRICAL $\nabla \times \mathbf{H} = \left(\frac{1}{\rho}\frac{\partial H_z}{\partial \phi} - \frac{\partial H_\phi}{\partial z}\right)\mathbf{a}_\rho + \left(\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial \rho}\right)\mathbf{a}_\phi + \frac{1}{\rho}\left[\frac{\partial(\rho H_\phi)}{\partial \rho} - \frac{\partial H_\rho}{\partial \phi}\right]\mathbf{a}_z$

SPHERICAL $\nabla \times \mathbf{H} = \frac{1}{r\sin\theta}\left[\frac{\partial(H_\phi \sin\theta)}{\partial \theta} - \frac{\partial H_\theta}{\partial \phi}\right]\mathbf{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial H_r}{\partial \phi} - \frac{\partial(rH_\phi)}{\partial r}\right]\mathbf{a}_\theta + \frac{1}{r}\left[\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial \theta}\right]\mathbf{a}_\phi$

LAPLACIAN

CARTESIAN $\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

CYLINDRICAL $\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho\frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$

SPHERICAL $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2}$

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INSTITUTE OF ENGINEERING

Examination Control Division

2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX 503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary figures are attached herewith.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Assume that the Bold Faced letter represents a vector and* $a_{subscript}$ represents a unit vector.

1. Find the vector that extends from A(-3,-4,6) to B(-5,2,-8) and express it in cylindrical coordinate system. [1+4]

2. A point charge of 12nC is located at the origin. Four uniform line charges are located in the x=0 plane as follow: 80nc/m at y=-1 and -5m, -50 nC/m at y=-2 and -4 m. Find the electric flux density **D** at P(0,-3,2). [7]

3. Let the region z<0 be composed of a uniform dielectric material for which ε_{R1}=3.2, while the region z>0 is characterized by ε_{R2}=2. Let $\mathbf{D}_1=-30\mathbf{a}_x+50\mathbf{a}_y+70\mathbf{a}_z$ nC/m^2 and find:- [7]

   a) $\mathbf{D}_{t1}$ (Tangential component of **D** in Region 1);
   b) Polarization ($\mathbf{P}_1$);
   c) $\mathbf{E}_{n2}$ (Normal component of **E** in Region 2)
   d) $\mathbf{E}_{t2}$ (Tangential component of **E** in Region 2)

4. Derive the Possion's and Laplace's equations. Assuming that the potential V in the cylindrical coordinate system is the function of 'r' only, solve the Laplace's equation by Integration Method an derive the expression for the capacitance of the Spherical Capacitor using the same solution of V. [2+5]

5. Derive the equation for magnetic field intensity in different regions due to a co-axial cable carrying a uniformly distributed dc current I in the inner conductor and –I in the outer conductor. [6]

6. Find the vector magnetic field intensity **H** in Cartesian coordinate at P(-1.5, -4, 3) caused by a current filament of 12A in the $\mathbf{a}_z$ direction on the z-axis and extending from z=-3 to z=3. [6]

7. Define Curl and give the physical interpretation of the Curl with a suitable example. [1+3]

8. A uniform plane wave in free space is propagating in the $-\mathbf{a}_y$ direction at a frequency of 5 MHz. If $\mathbf{E}=200\cos(\omega t+\beta y)\,\mathbf{a}_z$ V/m, write the expressions for electric and magnetic fields, i.e., $\mathbf{E}_s$ (x,y,z) and $\mathbf{H}_s$ (x, y, z) respectively in phasor forms. [3+5]

9. Derive an expression for Standing Wave Ratio (SWR) indicating where on the z-axis you'll get the maximum and minimum value of electric field intensity **E**. Assume that the boundary is at z=0, the region z<0 is a perfect dielectricand the region z>0 may be of any material. [8]

10. Find the amplitude of the displacement current density in an air space within a large power transformer where $\mathbf{H}=10^6 \cos(377t+1.2566 \times 10^{-6}z)\, a_y$ A/m. [6]

11. A lossless 50-Ω line is 1.5λ long and is terminated with a pure resistance of 100Ω. The load voltage is $40\underline{/60^\circ}$V. Find: (a) the average power delivered to the load; (b) the magnitude of the minimum voltage on the line. [4+4]

12. What are the advantages and disadvantages of waveguides when you compare it with transmission lines? Explain the transverse electric (TE) and transverse magnetic (TM) modes used in rectangular waveguides. [3+3]

13. Give the definition of an antenna and explain the properties of any one type of antenna that you have studied during your electromagnetics course. [1+1]

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11 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *The $\xrightarrow[\text{subscript}]{}$ denotes a unit vector along the direction of subscript.*
- ✓ *Necessary formulas are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Expres in cartesian components: (a) the vector at A($\rho = 4, \Phi = 40°, z = -2$) that extends to B($\rho = 5, \Phi = -110°, z = 2$); (b) a unit vector at B directed toward A. [3+2]

2. Derive an Electric Field Intensity $(\vec{E})$ in between the two co-axial cylindrical conductors, the inner of radius 'a' and outer of radius 'b', each infinite in extent and assuming a surface charge density ρ_s on the outer surface of the inner conductor. An infinite uniform line charge $\rho_L = 2$ nC/m lies along the x-axis in free space, while the point charge of 8nC each are located at (0, 0, 1). Find $\vec{E}$ at (2, 3, -4) [4+4]

3. Derive the integral and point forms of continuity equation. In a certain region, $\vec{j} = 3r^2 \cos\theta \vec{a}_r - r^2 \sin\theta \vec{a}_\theta \ A/m^2$. Find the current crossing the surface defined by $\theta = 30°, 0 < \phi < 2\pi, 0 < r < 2$. [5+3]

4. Given the field, $\vec{D} = \dfrac{5\sin(\theta)\cos(\phi)}{r} a_r C/m^2$, find: (a) the volume charge density; (b) the total charge contained in the region $r < 2$ m; (c) the value of D at the surface $r = 2$. [2+2+2]

5. Differentiate between scalar and vector magnetic potential. Derive the expression for magnetic boundary conditions. [3+5]

6. State Stroke's theorem. Evaluate both sides of Stroke's theorem for the field $\vec{G} = 10\sin\theta \hat{a}_\phi$ and the surface $r = 3, 0 \le \theta \le 2\pi, 0 \le \phi \le 90°$. Let the surface have the $\hat{a}_r$ direction. [1+7]

7. Find the capacitance of a spherical capacitor using Laplace's equation. [6]

8. Write point form of all the Maxwell's Equations in phasor domain, for perfect dielectric material. Use these equations to derive the magnetic field component of a uniform plan wave travelling in the perfect dielectric medium. [2+6]

9. Let $\vec{E}(z,t) = 1800\cos(10^7\pi t - \beta z)\vec{a}_x$ V/m and $\vec{H}(z,t) = 3.8\cos(10^7\pi t - \beta z)\vec{a}_y$ A/m represents a uniform plane wave propagating at a velocity of 1.4×10^8 m/s in perfect dielectic. Find a) β b) λ c) η d) μ_r e) ε_r . [2+1+2+2+1]

10. The velocity of propagation in a lossless transmission line 2.5×10^8 m/s. If the capacitance of the line is 30 pf/m, find: [2+2+2+2]

a) Inductance of the line
b) Characteristic impedance
c) Phase constant at 100 MHZ
d) Reflection coefficient if the line is terminated with a resistive load of 50Ω

11. What are the advantages of waveguides over transmission lines? A rectangular waveguide has a cross-section of 2.5 cm × 1.2 cm. Find the cut-off frequencies at dominant mode and TE (1,1) [1+4]

12. Write short notes on: Antenna properties [2]

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12 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *The $\overrightarrow{a_{subscript}}$ denotes a unit vector along the direction of subscript.*
- ✓ *Necessary formulas are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. An uniform Electric Field Intensity in certain region is given by $\vec{E} = y\vec{a}_x - xy\vec{a}_y + z\vec{a}_z$. Transform this field vector into cylindrical co-ordinate at a point P(2, 45°, 3). [5]
2. A uniform line charge density of 150 μC/m lies at x = 2, z = -4 and a uniform sheet of charge equal to 25 nC/m^2 is placed at z = 5 plane. Find $\vec{D}$ at point (1, 2, 4) and convert it to the spherical coordinate system. [5+3]
3. Given the potential function $V = \frac{20\cos\theta}{r^2}$ V in free space and point P is located at r = 3m, $\theta = 60°$, $\phi = 30°$ find: a) $\vec{E}_P$ b) $\frac{dV}{dN}$ at P c) unit normal vector at P d) ρ_v at P. [2+1+1+2]
4. Define Relaxation time Constant (RTC). Derive an expression for RTC. Given the vector current density $\vec{J} = 10\rho^2 z\vec{a}_\rho - 4\rho\cos^2\phi\vec{a}_\phi \text{ mA/m}^2$. Find the current flowing outward through the circular band $\rho = 3$, $0 < \phi < 2\pi$, $2 < z < 2.8$. [1+3+4]
5. Show that the vector magnetic potential can be defined in both the regions where $\vec{J}$ is equal or non-equal to zero. Use the concept of vector magnetic potential to derive the Magnetic Field Intensity due to an infinite current carrying filament carrying DC current I. [3+5]
6. State Stoke's theorem. Given the field $\vec{H} = \frac{1}{2}\cos\left(\frac{\phi}{2}\right)\vec{a}_\rho - \sin\left(\frac{\phi}{2}\right)\vec{a}_\Phi$ A/m, evaluate both sides of Stroke's theorem for the path formed by the intersection of the cylinder $\rho = 3$ and the plane z = 2, and for the surface defined by $\rho = 3$, $0 \le z \le 2$, and z = 0, $0 \le \rho \le 3$. [1+7]
7. State Faradays Law. Correct the equation $\nabla \times \vec{H} = \vec{J}$ with necessary arguments and derivation for time varying field. [2+4]
8. Derive the expressions for reflection coefficient and transmission coefficient for the reflection of uniform waves at normal incidence. [8]

9. At 50 MHz, a lossy dielectric material is characterized by $\epsilon = 3.6\epsilon_0$, $\mu = 2.1\mu_0$ and $\sigma = 0.08$ S/m. If $\vec{E}_s = 6e^{-\gamma x}\,\vec{a}_z\ \mathrm{V/m}$, Compute: [2+2+4]

a) Propagation Constant
b) Wavelength
c) $\vec{H}_s$

10. State the condition for lossless transmission line. A lossless transmission line is 80 cm long and operates at a frequency of 600 MHZ. The line parameters are L = 0.25μH/m and C = 100 pF/m. Find a) characteristics impedance b) phase constant c) phase velocity. [1+2+3+2]

11. Differentiate between Transmission line and waveguide. Consider a rectangular waveguide with $\epsilon_r = 2$, $\mu_r = 1$ with dimensions a = 1.07 cm, b = 0.43 cm find the cut off frequency for TM_{11} mode and the dominant mode. [1+4]

12. Write short notes on antenna and its parameters. [2]

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P.T.O

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate* ***Full Marks***.
- ✓ ***Necessary formula is attached herewith.***
- ✓ *$\vec{A}$ represents a vector and $\vec{a}_{subscript}$ denotes a unit vector along the direction given by the subscript.*
- ✓ *Assume suitable data if necessary.*

1. Convert the vector $\vec{F} = F_x\vec{a}_x + F_y\vec{a}_y + F_z\vec{a}_z$ to both spherical coordinate system. [5]

2. Find the electric field intensity in all three regions due to an infinite sheet parallel plate capacitor having surface charge density ρ_s c/m^2 and $-\rho_s$ c/m^2 and placed at y = 0 and y = b respectively. Let a uniform line charge density, 3 nC/m, at y = 3; uniform surface charge density, 0.2 nC/m^2 at x = 2. Find $\vec{E}$ at the origin. [4+4]

3. What is dipole? Derive the equation for potential and electric field due to dipole at a distant point P. [1+6]

4. Derive Poisson's equation. By solving Laplace's equation, find the capacitance of a parallel plate capacitor with potential difference between the plates equals V_o. [1+5]

5. Verify stoke's theorem for the field $\vec{H} = \left(\frac{3r^2}{\sin\theta}\right)\vec{a}_\theta + 54r\cos\theta\,\vec{a}_\phi$ A/m in free space for the conical surface defined by $\theta = 20°$, $0 \le \phi \le 2\pi$, $0 \le r \le 5$. Let the positive direction of $\vec{ds}$ be $\vec{a}_\theta$. [8]

6. Consider a boundary at z = 0 for which $\vec{B}_1 = 2\vec{a}_x - 3\vec{a}_y + \vec{a}_z$ mT, $\mu_1 = 4$ μH/m (z > 0), $\mu_2 = 7$ μH/m (z < 0) and $\vec{K} = 80\vec{a}_x$ A/m at z = 0. Find $\vec{B}_2$ [8]

7. Explain how Ampere's law conflict with continuity equation and how it is corrected? Derive conduction and displacement current in a capacitor. [4+3]

8. Derive the expression for electric and magnetic fields for a uniform plane wave propagating in a perfect dielectric medium. [5+3]

9. A 9.4 GHz uniform plane wave is propagating in a medium with $\epsilon_r = 2.25$ an $\mu_r = 1$. If the magnetic field intensity is 7 mA/m and the material is loss less, find [1+1+1+2+2]

   i) Velocity of propagation
   ii) The wave length
   iii) Phase constant
   iv) Intrinsic impedance
   v) Magnitude of electric field intensity

10. A lossless line having an air dielectric has a characteristics impedance of 400 Ω. The line is operating at 200 MHz and $z_{in} = 200 - j200\,\Omega$. Find (a) SWR (b) Z_L, if the line is 1 m long; (c) the distance from the load to the nearest voltage maximum. [2+4+2]

11. Differentiate between transmission line and waveguide. A rectangular waveguide having cross-section of 2 cm× 1 cm is filled with a lossless medium characterized by $\varepsilon = 4\varepsilon_0$ and $\mu_r = 1$. Calculate the cut-off frequency of the dominant mode. [4+2]

12. Write short notes on antenna and its properties. [2]

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DIVERGENCE

CARTESIAN $\nabla\cdot\bar{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$

CYLINDRICAL $\nabla\cdot\bar{D} = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho D_\rho) + \frac{1}{\rho}\frac{\partial D_\phi}{\partial\phi} + \frac{\partial D_z}{\partial z}$

SPHERICAL $\nabla\cdot\bar{D} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 D_r) + \frac{1}{r\sin\theta}\frac{\partial(\sin\theta\, D_\theta)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial\phi}$

GRADIENT

CARTESIAN $\nabla V = \frac{\partial V}{\partial x}\hat{a}_x + \frac{\partial V}{\partial y}\hat{a}_y + \frac{\partial V}{\partial z}\hat{a}_z$

CYLINDRICAL $\nabla V = \frac{\partial V}{\partial\rho}\hat{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial\phi}\hat{a}_\phi + \frac{\partial V}{\partial z}\hat{a}_z$

SPHERICAL $\nabla V = \frac{\partial V}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial V}{\partial\theta}\hat{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi}\hat{a}_\phi$

CURL

CARTESIAN $\nabla\times\bar{H} = \left(\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}\right)\hat{a}_x + \left(\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right)\hat{a}_y + \left(\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right)\hat{a}_z$

CYLINDRICAL $\nabla\times\bar{H} = \left(\frac{1}{\rho}\frac{\partial H_z}{\partial\phi} - \frac{\partial H_\phi}{\partial z}\right)\hat{a}_\rho + \left(\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial\rho}\right)\hat{a}_\phi + \frac{1}{\rho}\left(\frac{\partial(\rho H_\phi)}{\partial\rho} - \frac{\partial H_\rho}{\partial\phi}\right)\hat{a}_z$

SPHERICAL $\nabla\times\bar{H} = \frac{1}{r\sin\theta}\left(\frac{\partial(H_\phi\sin\theta)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}\right)\hat{a}_r + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial(rH_\phi)}{\partial r}\right)\hat{a}_\theta$

$+\frac{1}{r}\left(\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial\theta}\right)\hat{a}_\phi$

LAPLACIAN

CARTESIAN $\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

CYLINDRICAL $\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial V}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial\phi^2} + \frac{\partial^2 V}{\partial z^2}$

SPHERICAL $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial V}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial\phi^2}$

22 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ __*Necessary formula is attached herewith.*__
- ✓ *$\vec{A}$ represents a vector and $\vec{a}_{subscript}$ denotes a unit vector along the direction given by the subscript.*
- ✓ *Assume suitable data if necessary.*

1. Express a scalar potential field $V = x^2 + 2y^2 + 3z^2$ in spherical coordinates. Find value of V at a point P(2,60°,90°). [3+2]
2. Derive the expression of Electric field intensity due to a line charge using Gauss Law. Find Electric flux density at point P(5,4,3) due to a uniform line charge of 2 nC/m at x = 5, y = 3, point charge 12 nC at Q(2,0,6) and uniform surface charge density of 0.2 nC/m^2 at x = 2. [4+4]
3. State the physical significance of divergence. Derive the Divergence theorem. Given the potential $V = \frac{10}{r^2}\sin\theta\cos\phi$; find the electric flux density $\vec{D}$ at $\left(2, \frac{\pi}{2}, 0\right)$. [2+2+3]
4. Derive Laplace's equation. Find the capacitance of a co-axial cable using Laplace's equation. [1+5]
5. State Ampere's circuital law. By using Biot Savart's law, derive an expression for magnetic field intensity $\left(\vec{H}\right)$ due to an infinite length filament carrying a direct current I. [2+6]
6. Flux density at medium with $\mu_1 = 15$ is $\vec{B}_1 = 1.2a_x + 8a_y + 4a_z T$. Find $\vec{B}, \vec{H}$ and the angles between the field vectors and tangent to the interface at second medium, if second medium has $\mu_2 = 1$, and interface plane is z = 0. [3+2+3]
7. State and derive the expression of motional emf (electromotive force). Consider two parallel conductors placed at x = 0 and x = 5 cm in a magnetic field $\vec{B} = 6\vec{a}_z \, mWb/m^2$. A high resistance voltmeter is connected at one end and a conducting bar is sliding at other end with velocity $\vec{v} = 18\vec{a}_y \, m/s$. Calculate the induced voltage and show the polarity of induced voltage across the voltmeter. [1+3+3]
8. What is standing wave? Derive the equation of Electric field and Magnetic field and SWR of standing wave? [1+7]

9. An EM wave travels in free space with the electric field component $\vec{E} = \left(15\vec{a}_y - 5\vec{a}_z\right)$ $\cos(\omega t - 3y + 5z) V/m$. Find (a) ω and λ (b) the magnetic field component. [2+2+3]

10. A 50Ω lossless transmission line is 30 m long and is terminated with a load $Z_L = 60 + j40\Omega$. The operating frequency is 20 MHz and velocity on the line is 2.5×10^8 m/s. Find [2+2+4]

    i) Reflection coefficient
    ii) Standing wave ratio
    iii) Input impedance

11. Explain TE and TM modes? Consider a rectangular waveguide with $\varepsilon r = 2.25$ and $\mu_r = 1$ with dimensions a = 1.07, b = 0.43. Find the cut-off frequency for TM_{11} mode and dominant mode. [2+4]

12. Write short notes on antenna and its type. [2]

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26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *__Necessary tables are attached herewith.__*
- ✓ $\vec{A}$ *represent a vector and* $\hat{a}_{subscript}$ *and* $\vec{a}_{subscript}$ *denotes a unit vector along the direction given by the subscript.*
- ✓ *Assume suitable data if necessary.*

1. Define a vector field. A field vector is given by an expression $\vec{A} = \frac{1}{\sqrt{x^2+y^2+z^2}}\left(X\vec{a}_x + y\vec{a}_y + z\vec{a}_z\right)$, transform this vector in cylindrical coordinate system at point (2, 30°, 6) [2+3]

2. Given the flux density $\vec{D} = (2\cos\theta/r^3)\vec{a}_r + (\sin\theta/r^3)\vec{a}_\theta\ C/m^2$, evaluate both sides of the divergence theorem for the region defined by $1 < r < 2, 0 < \theta < \frac{\pi}{2}, 0 < \phi < \frac{\pi}{2}$. [8]

3. Define electric dipole and polarization. The region z < 0 contains a dielectric material for which $\varepsilon_{r1} = 2.5$ while the region z > 0 is characterized by $\varepsilon_{r2} = 4$. Let $\vec{E}_1 = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z\ V/m$. Find: (a) $\vec{E}_2$ (b) $\vec{D}_2$ (c) polarization in region 2 $\left(\vec{P}_2\right)$. [2+2+2+1+1]

4. State the uniqueness theorem and prove this theorem for Laplace's equation. [1+5]

5. A current density in certain region is given as: $\vec{J} = 20\sin\theta\cos\phi\,\vec{a}_r + \frac{1}{r}\vec{a}_\phi\ A/m^2$, Find: [5+3]

   i) The average value of J_r over the surface $r = 1, 0 < \theta < \pi/2, 0 < \phi < \pi/2$

   ii) $\frac{\delta\rho_v}{\partial t}$

6. Show that $\nabla \times \vec{E} = 0$ for static electric field. The region y<0 (Region 1) is air and y>0 (Region 2) has μ_r = 10. If there is a uniform magnetic field $\vec{H} = 5\vec{a}_x + 6\vec{a}_y + 7\vec{a}_z\ A/m$ in region 1, find $\vec{B}$ and $\vec{H}$ in region 2. [2+3+3]

7. Find the amplitude of the displacement current density in a metallic conductor at 60 Hz, if $\varepsilon = \varepsilon_0, \mu = \mu_0, \sigma = 5.8\times10^7 S/m$, and $\vec{J} = \sin(377t - 117.1z)\vec{a}_x\ MA/m^2$. [5]

8. Explain the phenomena when a plane wave is incident normally on the interface between two different Medias. Derive the expression for reflection and transmission coefficient. [8]

9. A uniform plane wave in non-magnetic medium has $\vec{E} = 50\cos(10^8 t + 2z)\hat{a}_y \text{ V/m}$. Find:

   i) The direction of propagation
   ii) Phase constant β, wavelength λ, velocity v_p, relative permittivity ε_r, intrinsic impedance η
   iii) $\vec{H}$ [1+5+2]

10. Determine the primary constants (R, L, C and G) on the transmission line when the measurement on the line at 1 KHz gave the following results: $z_0 = 710\angle{-16°}$, $\alpha = 0.01$ neper/m and $\beta = 0.035$ rad/m. [8]

11. Explain the modes supported by a rectangular waveguide. Calculate the cut off frequencies of the first four propagating modes for an air filled copper waveguide with dimension $a = 2.5\text{ cm}$, $b = 1.2$ cm. [2+4]

12. Write short notes on antenna and its types. [2]

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *$\vec{A}$ represent a vector and $\hat{a}_{subscript}$ and $\vec{a}_{subscript}$ denotes a unit vector along the direction given by the subscript.*
- ✓ *Assume suitable data if necessary.*

1. Express the uniform vector field $\vec{F} = 5\vec{a}_x$ in (a) cylindrical components (b) spherical components. [2+3]
2. Derive the expression for the electric field intensity due to an infinitely long line charge with uniform charge density ρ_L by using Gauss's law. A uniform line charge density of 20 nC/m is located at $y = 3$ and $z = 5$. Find $\vec{E}$ at P(5,6,1) [4+4]
3. Derive an expression to calculate the potential due to a dipole in terms of the dipole moment $\left(\vec{p}\right)$. A dipole for which $\vec{p} = 3\vec{a}_x - 5\vec{a}_y + 10\vec{a}_z$ nC.m is located at the point (1,2,-4). Find $\vec{E}$ at P. [4+4]
4. Assuming that the potential V in the cylindrical coordinate system is function of ρ only, solve the Lapplace's equation and derive the expression for the capacitance of coaxial capacitor of length L using the same solution of V. Assume the inner conductor of radius a is at potential V_0 with respect to the conductor of radius b. [6]
5. State and derive expression for Stoke's theorem. Evaluate the closed line integral of $\vec{H}$ from $P_1(5,4,1)$ to $P_2(5,6,1)$ to $P_3(0,6,1)$ to $P_4(0,4,1)$ to P_1 using straight line segments, if $\vec{H} = 0.1y^3\vec{a}_x + 0.4x\vec{a}_z$ A/m. [1+3+4]
6. Define scalar magnetic potential and show that it satisfies the Laplace's equation. Given the vector magnetic potential $\vec{A} = -(\rho^2/4)\hat{a}_z$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \le \rho \le 2$ m and $0 \le z \le 5$ m. [1+2+5]
7. How does $\nabla \times \vec{H} = \vec{J}$ conflict with continuity equation in time varying fields. How is this conflict rectified in such fields? [2+3]
8. Derive the expression for electric and magnetic fields for a uniform plane wave propagating in a perfect dielectric space. [5+3]
9. A lossless dielectric material has $\sigma = 0, \mu_r = 1, \varepsilon_r = 4$. An electromagnetic wave has magnetic field expressed as $\vec{H} = -0.1\cos(\omega t - z)\vec{a}_x + 0.5\sin\cos(\omega t - z)\vec{a}_y$ A/m. Find: [2+2+4]
   a) Angular frequency (ω)
   b) Wave impedance (η)
   c) $\vec{E}$

10. Consider a two-wire 40 Ω line $(Z_0 = 40\Omega)$ connecting the source of 80 V, 400 kHz with series resistance 10 Ω to the load of $Z_L = 60\Omega$. The line is 75 m long and the velocity on the line is 2.5×10^8 m/s. Find the voltage $V_{in,s}$ at input end and $V_{L,s}$ at output end of the transmission line. [8]

11. Why does a hollow rectangular waveguide not support TEM mode? A rectangular air-filled waveguide has a cross-section of 45×90 mm. Find the cut-off frequencies of the first four propagating modes. [2+4]

12. Write short notes on antenna and its types. [2]

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DIVERGENCE

CARTESIAN $\nabla\cdot\bar{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$

CYLINDRICAL $\nabla\cdot\bar{D} = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho D_\rho\right) + \frac{1}{\rho}\frac{\partial D_\phi}{\partial\phi} + \frac{\partial D_z}{\partial z}$

SPHERICAL $\nabla\cdot\bar{D} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 D_r\right) + \frac{1}{r\sin\theta}\frac{\partial\left(\sin\theta\, D_\theta\right)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial\phi}$

GRADIENT

CARTESIAN $\nabla V = \frac{\partial V}{\partial x}\hat{a}_x + \frac{\partial V}{\partial y}\hat{a}_y + \frac{\partial V}{\partial z}\hat{a}_z$

CYLINDRICAL $\nabla V = \frac{\partial V}{\partial\rho}\hat{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial\phi}\hat{a}_\phi + \frac{\partial V}{\partial z}\hat{a}_z$

SPHERICAL $\nabla V = \frac{\partial V}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial V}{\partial\theta}\hat{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi}\hat{a}_\phi$

CURL

CARTESIAN $\nabla\times\bar{H} = \left(\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}\right)\hat{a}_x + \left(\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right)\hat{a}_y + \left(\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right)\hat{a}_z$

CYLINDRICAL $\nabla\times\bar{H} = \left(\frac{1}{\rho}\frac{\partial H_z}{\partial\phi} - \frac{\partial H_\phi}{\partial z}\right)\hat{a}_\rho + \left(\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial\rho}\right)\hat{a}_\phi + \frac{1}{\rho}\left(\frac{\partial\left(\rho H_\phi\right)}{\partial\rho} - \frac{\partial H_\rho}{\partial\phi}\right)\hat{a}_z$

SPHERICAL $\nabla\times\bar{H} = \frac{1}{r\sin\theta}\left(\frac{\partial\left(H_\phi\sin\theta\right)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}\right)\hat{a}_r + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial\left(rH_\phi\right)}{\partial r}\right)\hat{a}_\theta$

$+\frac{1}{r}\left(\frac{\partial\left(rH_\theta\right)}{\partial r} - \frac{\partial H_r}{\partial\theta}\right)\hat{a}_\phi$

LAPLACIAN

CARTESIAN $\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

CYLINDRICAL $\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial V}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial\phi^2} + \frac{\partial^2 V}{\partial z^2}$

SPHERICAL $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial V}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial\phi^2}$

22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary formula sheet is attached herewith.*
- ✓ $\vec{a}_{subscript}$ *denote a unit vector along the direction given by the subscript.*
- ✓ *Assume suitable data if necessary.*

1. Transform $\vec{A} = 10\vec{a}_x - 8\vec{a}_y + 6\vec{a}_z$; at point p(10,-8,6) to cylindrical coordinate system. [5]

2. A line charge of 8nC/m is located at x = -1, y = 2, a point charge of 6mC at y = -4 and a surface charge of 30 pC/m^2 at z = 0. If the potential at origin is 100V, find the potential at P (4,1,3). [7]

3. Explain the Continuity equation. The current density in certain region is approximated by $\vec{J} = \left(\frac{0.1}{r}\right)e^{-10^6 t}\,\vec{a}_r\ A/m^2$ in spherical coordinates. (a) How much current is crossing the surface r = 50cm at t = 1μS? (b) Find ρ_v (r,t) assuming that $\rho_v \to 0$ as $t \to \infty$. [2+6]

4. Find the equation for Energy Density in the electrostatic field. [6]

5. Differentiate between scalar and vector magnetic potential. Derive an expression for the magnetic field intensity $\left(\vec{H}\right)$ at a point due to an infinite filament carrying a direct current I, placed on z-axis using ampere's circuital law. [2+6]

6. State and prove Stoke's theorem. Given $\vec{H} = 10\sin\theta\,\vec{a}_r$ in free space. Find the current in $\vec{a}_r$ direction having $r = 3, 0 \le \theta \le 90°, 0 \le \phi \le 90°$. [3+5]

7. Within a certain region, $\varepsilon = 10^{-11}$ F/m and $\mu = 10^{-5}$ H/m.

   If $\vec{B}_x = 2\times10^{-4}\cos 10^5 t \sin 10^{-3} y\,\vec{a}_x$ T: (a) Use $\nabla\times\vec{H} = \varepsilon\frac{\partial\vec{E}}{\partial t}$ to find $\vec{E}$; (b) Find the total magnetic flux passing through the surface x = 0, $0 \le y \le 40$m, $0 \le z \le 2$m, at t = 1μS. [4+4]

8. Derive an expression for standing wave ratio of uniform plane wave in terms of reflection coefficient. Find the reflection coefficient for the interface between air and fresh water ($\epsilon = 81\epsilon_0, \sigma \cong 0$), in case of normal incidence. [5+3]

9. The magnetic field intensity $\left(\vec{H}\right)$ in free space is given as,

$\vec{H}(x,t) = 10\cos(10^8 t + \beta x)\vec{a}_y \ A/m$ find: [2+1+3]

a) Phase constant (β)
b) Wavelength
c) $\left|\vec{E}(x,t)\right|$ at P (0.1,0.2,0.3) at t = 1nS

10. A 300 Ω transmission line is lossless, 0.25λ long, and is terminated in $Z_L = 500\ \Omega$. The line has a generator with 90 ∠0°V in series with 100 Ω connected to the input. Find (a) the load voltage (b) voltage at the midpoint of the line. [4+4]

11. Determine the cut-off frequency for an air filled rectangular waveguide with a = 2.5 cm and b = 1.25 cm for TE_{11} mode. [4]

12. Write short notes on: [2+2]

a) Loss tangent

b) Antenna types and properties

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B.E.X.
II/I

26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics (EX503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ ***__Necessary formulas are attached herewith.__***
- ✓ *Assume suitable data if necessary.*
- ✓ Assume that the **Bold Faced** letter represents a vector and $\mathbf{a}_{subscipt}$ represents a unit vector.

(1) Express the vector field, $\mathbf{G} = (x^2 + y^2)^{-1}(x\mathbf{a}_x + y\mathbf{a}_y)$ in cylindrical components and cylindrical variables. [5]

(2) Find **D** at the point (-3, 4, 2) if the following charge distributions ~~are present in free space: point charge, 12 nC, at P (2, 0, 6);~~ uniform line charge density, 3 nC/m, at x = -2, y = 3; uniform surface charge density, 0.2 nC/m^2 at x = 2. [7]

(3) Two uniform line charges, 8 nC/m each, are located at x = 1, z = 2, and at x = -1, y = 2 in free space. If the potential at the origin is 100V, find V at P (4, 1, 3). [7]

(4) State the Uniqueness theorem and prove that the solution of Poisson's equation is unique. [1+6]

(5) Write the equation of the Vector Magnetic Potential in differential form. Using the same equation, derive the equation for magnetic field intensity at a point due to an infinite filament carrying a uniformly distributed dc current I. [1+5]

~~(6) Calculate the value of the vector current density: (a) in cylindrical~~ coordinates at P_1 (ρ=1.5, ϕ=90°, z=0.5) if $\mathbf{H} = \frac{2}{\rho}(\cos 0.2\phi)\ \mathbf{a}_\rho$. [3+3]

(b) in spherical coordinates at P_2 (r=2, θ=30°, ϕ=20°) if $\mathbf{H} = \frac{1}{\sin\theta}\ \mathbf{a}_\theta$.

(7) State and derive the Stoke's theorem. [1+3]

(8) What is an input intrinsic impedance? Derive an expression for the input intrinsic impedance using the concept of reflection of uniform plane waves. [2+6]

(9) The electric field amplitude of a uniform plane wave propagating in the free space in $\mathbf{a}_z$ direction is 250 V/m. If $\mathbf{E} = E_x \mathbf{a}_x$ and ω = 1.00 Mrad/s, find: (a) the frequency; (b) the wavelength; (c) the period; (d) the amplitude of H. [2+2+1+3]

(10) Find the amplitude of the displacement current density inside a typical metallic conductor where f = 1 kHz, Conductivity $\sigma = 5 \times 10^7$ mho/m, dielectric constant $\varepsilon_R = 1$; and the conduction current density $\mathbf{J} = 10^7 \sin(6283\,t - 444\,z)\,\mathbf{a}_x$ A/m^2. [6]

(11) A 50-Ω lossless line has a length of 0.4λ. The operating frequency is 300 MHz. A load $Z_L = 40 + j30\ \Omega$ is connected at z = 0, and the Thevenin equivalent source at z = -l is $12\angle 0^\circ$ in series with $Z_{Th} = 50 + j0\ \Omega$. Find: (a) The Reflection Coefficient Γ (b) The Voltage Standing Wave Ratio (VSWR) and (c) The input Impedance Z_{in}. [2+2+4]

(12) Explain why is it not possible to use waveguides at lower frequencies? Explain the transverse electric (TE) and transverse magnetic (TM) modes used in rectangular waveguides. [2+4]

(13) Give the definition of an antenna. Explain the properties of any one type of antenna that you have studied during your electromagnetics course. [1+1]

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26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary formula are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Transform the Vector $\vec{A} = y\vec{a}_x + x\vec{a}_y + z\vec{a}_z$ into cylindrical co-ordinates at a point p(2,45°,5) [5]
2. Along the z-axis there is a uniform line of charge with $\rho_L = 4\pi$ Cm^{-1} and in the x = 1 plane there is a surface charge with $\rho_s = 20$ Cm^{-2}. Find the Electric Flux Density at (0.5, 0, 0) [6]
3. Define Uniqueness theorem. Assuming that the potential V in the cylindrical coordinate system is the function of 'ρ' only, solve the Laplacian Equation by integration method and derive the expression for the Capacitance of the co-axial capacitor using the same solution of V. [2+5]
4. Define Electric Dipole and Polarization. Consider the region y < 0 be composed of a uniform dielectric material for which the relative permittivity (ε_r) is 3.2 while the region y > 0 is characterized by $\varepsilon_r = 2$. Let the flux density in region 1 be [2+3+3]

   $$\vec{D}_1 = -30\vec{a}_x + 50\vec{a}_y + 70\vec{a}_z \, nC/m^2.$$

   Find:
   a) Magnitude of Flux density and Electric fields intensity at region 2.
   b) Polarization $(\vec{P})$ in region 1 and region 2
5. State Ampere's circuital law and stoke's theorem. Derive an expression for magnetic field intensity $(\vec{H})$ due to infinite current carrying filament using Biot Savart's Law. [1+2+5]
6. Differentiate between scalar and vector magnetic potential. The magnetic field intensity in a certain region of space is given as $\vec{H} = (2\rho + z)\vec{a}_\rho + \frac{2}{z}\vec{a}_z$ A/m. Find the total current passing through the surface $\rho = 2$, $\pi/4 < \varphi < \pi/2$, $3 < z < 5$, in the $\vec{a}_\rho$ direction. [3+5]
7. State Faraday's law and correct the equation $\nabla \times \vec{E} = 0$ for time varying field with necessary derivation. Also modify the equation $\nabla \times \vec{H} = \vec{J}$ with necessary derivations for time varying field. [1+3+4]
8. Derive an expression for input intrinsic impendence using the concept of reflection of uniform plane waves. [6]

9. Find the amplitude of displacement current density inside a typical metallic conductor where $f = 1KHz$, $\sigma = 5\times10^7$ mho/m, $\varepsilon_r = 1$ and the conduction current density is $\vec{J} = 10^7 \sin(6283t - 444z)\hat{a}_y \, A/m^2$ [4]

10. Write all the Maxwell equations for the time varying field point form as well as integral form. [4]

11. A lossless transmission line with $Z_0 = 50\ \Omega$ with length 1.5 m connects a voltage $V_g = 60\angle V$ source to a terminal load of $Z_L = (50+j50)\ \Omega$. If the operating frequency $f = 100$ MHz, generator impedence $Z_g = 50\ \Omega$ and speed of wave equal to the speed of the light. Find the distance of the first voltage maximum from the load. What is the power delivered to the load? [4+4]

12. What are the techniques that can be taken to match the transmission line with mismatched load? Explain any one. [2]

13. Write short notes on: [2×3]

   a) Modes in rectangular wave guide
   b) Antenna and its types

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27 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX 503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary formulas are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Given a vector field $\vec{D} = \dfrac{x\vec{a}_x + y\vec{a}_y}{x^2+y^2}$, evaluate D at the point where ρ=2, Φ=0.2π, and Z=5 in both cylindrical and Cartesian components. [5]
2. Define Gauss's law. A co-axial cable has inner conductors of radius r_1, outer conductor of radius r_2. Surface charge density on the surface of inner conductors is ρ_s. Use Gauss's law to derive an expression for electric field intensity in the region $r_1 \le r \le r_2$. [2+5]
3. Define potential field. Assuming that the potential V in the spherical coordinate system is function of r only, solve the laplacian equation and derive the expression for the capacitance of a spherical capacitor using the same solution of V. [1+6]
4. Use boundary condition to find $\vec{E}_2$ in the medium 2 with boundary located at plane Z=0. Medium 1 is perfect dielectric characterized by ε_{r1}=2.5, medium 2 is perfect dielectric characterized by ε_{r2}=5, electric field in medium 1 is $\vec{E}_1 = \hat{a}_x + 3\hat{a}_y + 3\hat{a}_z$ v/m. [7]
5. Given the magnetic vector potential $\vec{A} = -\dfrac{\rho^2}{4}\vec{a}_z$ Wb/m, Calculate the total magnetic flux crossing the surface Φ=π/2, $1 \le \rho \le 2$m, $0 \le Z \le 5$m. [6]
6. Find the boundary condition for H and B at the interface between two isotropic homogeneous linear materials with permeabilities μ_1 and μ_2. [6]
7. For magnetic vector potential given in cylindrical co-ordinate system as $\bar{A} = 5r^3\hat{a}_z$ Wb/m in free space, find the magnetic field intensity, $\bar{H}$. [4]
8. Derive the equations to show that the electric field and the magnetic field components are in same phase for the wave propagation in perfect dielectric medium. [8]
9. Derive expressions for reflection co-efficient and transmission co-efficient for the case of normal incidence at boundary between two dielectric media where medium 1 is characterized by permittivity ε_1, permeability μ_1 and medium 2 is characterized by permittivity ε_2, permeability μ_2. Also explain why the concept of reflection is necessary. [5+3]
10. Write down the Maxwell's equations in point and phasor form for time varying fields. Define the pointing vector. [4+2]
11. A load impedance of (40+j70)Ω terminates a 100Ω transmission line that is 0.3λ long. Find the reflection coefficient at the load and the voltage at the input of the line. [2+4]
12. Define transverse electric and transverse magnetic mode of wave propagation in wave guide. A rectangular wave guide has dimensions a = 4.5cm, b=2.5cm. The medium within wave guide has relative permittivity ε_r=1, relative permeability u_r=1, conductivity σ=0 and conducting walls of wave guide are perfect conductors. Determine the cut off frequency for the modes $TE_{(1,0)}$, and $TM_{(1,1)}$. [2+2+2+2]
13. Write short notes on antenna and its properties. [2]

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Divergence

Cartesian: $\nabla.\overline{A}=\dfrac{\partial A_x}{\partial x}+\dfrac{\partial A_y}{\partial y}+\dfrac{\partial A_z}{\partial z}$

Cylindrical: $\nabla.\overline{A}=\dfrac{1}{r}\dfrac{\partial}{\partial r}(rA_r)+\dfrac{1}{r}\dfrac{\partial A_\phi}{\partial \phi}+\dfrac{\partial A_z}{\partial z}$

Spherical: $\nabla.\overline{A}=\dfrac{1}{R^2}\dfrac{\partial}{\partial R}(R^2A_R)+\dfrac{1}{R\sin\theta}\dfrac{\partial}{\partial\theta}(A_\theta\sin\theta)+\dfrac{1}{R\sin\theta}\dfrac{\partial A_\phi}{\partial\phi}$

Gradient

Cartesian: $\nabla A=\dfrac{\partial A}{\partial x}\hat{a}_x+\dfrac{\partial A}{\partial y}\hat{a}_y+\dfrac{\partial A}{\partial z}\hat{a}_z$

Cylindrical: $\nabla A=\dfrac{\partial A}{\partial r}\hat{a}_r+\dfrac{1}{r}\dfrac{\partial A}{\partial\phi}\hat{a}_\phi+\dfrac{\partial A}{\partial z}\hat{a}_z$

Spherical: $\nabla A=\dfrac{\partial A}{\partial R}\hat{a}_R+\dfrac{1}{R}\dfrac{\partial A}{\partial\theta}\hat{a}_\theta+\dfrac{1}{R\sin\theta}\dfrac{\partial A}{\partial\phi}\hat{a}_\phi$

Curl

Cartesian: $\nabla\times\overline{A}=(\dfrac{\partial A_z}{\partial y}-\dfrac{\partial A_y}{\partial z})\hat{a}_x+(\dfrac{\partial A_x}{\partial z}-\dfrac{\partial A_z}{\partial x})\hat{a}_y+(\dfrac{\partial A_y}{\partial x}-\dfrac{\partial A_x}{\partial y})\hat{a}_z$

Cylindrical: $\nabla\times\overline{A}=(\dfrac{1}{r}\dfrac{\partial A_z}{\partial\phi}-\dfrac{\partial A_\phi}{\partial z})\hat{a}_r+(\dfrac{\partial A_r}{\partial z}-\dfrac{\partial A_z}{\partial r})\hat{a}_\phi+\dfrac{1}{r}(\dfrac{\partial}{\partial r}(rA_\phi)-\dfrac{\partial A_r}{\partial\phi})\hat{a}_z$

Spherical:

$$\nabla\times\overline{A}=\frac{1}{R\sin\theta}(\frac{\partial}{\partial\theta}(A_\phi\sin\theta)-\frac{\partial A_\theta}{\partial\phi})\hat{a}_R+\frac{1}{R}(\frac{1}{\sin\theta}\frac{\partial A_R}{\partial\phi}-\frac{\partial}{\partial R}(RA_\phi))\hat{a}_\theta+\frac{1}{R}(\frac{\partial}{\partial R}(RA_\theta)-\frac{\partial A_R}{\partial\theta})\hat{a}_\phi$$

Laplacian

Cartesian: $\nabla^2A=\dfrac{\partial^2A}{\partial x^2}+\dfrac{\partial^2A}{\partial y^2}+\dfrac{\partial^2A}{\partial z^2}$

Cylindrical: $\nabla^2A=\dfrac{1}{r}\dfrac{\partial}{\partial r}(r\dfrac{\partial A}{\partial r})+\dfrac{1}{r^2}\dfrac{\partial^2A}{\partial\phi^2}+\dfrac{\partial^2A}{\partial z^2}$

Spherical: $\nabla^2A=\dfrac{1}{R^2}\dfrac{\partial}{\partial R}(R^2\dfrac{\partial A}{\partial R})+\dfrac{1}{R^2\sin\theta}\dfrac{\partial}{\partial\theta}(\sin\theta\dfrac{\partial A}{\partial\theta})+\dfrac{1}{R^2\sin^2\theta}\dfrac{\partial^2A}{\partial\phi^2}$

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INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electromagnetics *(EX 503)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary formulas are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Transform vector $\vec{A} = \rho \sin\phi \vec{a}_z$ at point (1, 45°, 2) in cylindrical co-ordinate system to a vector in spherical co-ordinate system. [5]
2. The region X<0 is composed of a uniform dielectric material for which $\varepsilon_{r1} = 3.2$, while the region X>0 is characterized by $\varepsilon_{r2} = 2$. The electric flux density at region X<0 is $\vec{D}_1 = -30\vec{a}_x + 50\vec{a}_y + 70\vec{a}_z$ nC/m^2 then find polarization ($\vec{P}$) and electric field intensity ($\vec{E}$) in both regions. [3+3]
3. Define an electric dipole. Derive expression for electric field because of electric dipole at a distance that is large compared to the separation between charges in the dipole. [2+6]
4. Define Relaxation Time Constant and derive an expression for the continuity equation. [3+4]
5. Derive the equations for magnetic field intensity for infinite long coaxial transmission line carrying direct current I and return current -I in positive and negative Z-direction respectively. [7]
6. A current carrying square loop with vertices A(0,–2,2), B(0,2,2), C(0,2,–2) D(0,–2,–2) is carrying a dc current of 20A in the direction along A-B-C-D-A. Find magnetic field intensity $\vec{H}$ at centre of the current carrying loop. [6]
7. Elaborate the significance of a curl of a vector field. [3]
8. Derive the expressions for the electric field $\vec{E}$ and magnetic field $\vec{H}$ for the wave propagation in free space. [8]
9. The phasor component of electric field intensity in free space is given by $\vec{E}_s = (100\angle 45°)e^{-j50z}\ \vec{a}_x$ v/m. Determine frequency of the wave, wave impedance, $\vec{H}_s$, and magnitude of $\vec{E}$ at z = 10mm, t = 20ps. [2+2+2+2]
10. Write short notes on: (a) Loss tangent (b) Skin depth and (c) Displacement current density. [2+2+2]
11. Explain impedance matching using both quarter wave transformer and single stub methods. [3+3]
12. Explain in brief the modes supported by rectangular waveguides. Consider a rectangular waveguide with $\varepsilon_r = 2$, $\mu = \mu_0$ with dimensions a = 1.07cm, b = 0.43cm. Find the cut off frequency for TM_{11} mode and the dominant mode. [4+2+2]
13. Define antenna and list different types of antenna. [2]

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Divergence

Cartesian: $\nabla . \overline{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$

Cylindrical: $\nabla . \overline{A} = \frac{1}{r}\frac{\partial}{\partial r}(rA_r) + \frac{1}{r}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$

Spherical: $\nabla . \overline{A} = \frac{1}{R^2}\frac{\partial}{\partial R}(R^2 A_R) + \frac{1}{R\sin\theta}\frac{\partial}{\partial \theta}(A_\theta \sin\theta) + \frac{1}{R\sin\theta}\frac{\partial A_\phi}{\partial \phi}$

Gradient

Cartesian: $\nabla A = \frac{\partial A}{\partial x}\hat{a}_x + \frac{\partial A}{\partial y}\hat{a}_y + \frac{\partial A}{\partial z}\hat{a}_z$

Cylindrical: $\nabla A = \frac{\partial A}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial A}{\partial \phi}\hat{a}_\phi + \frac{\partial A}{\partial z}\hat{a}_z$

Spherical: $\nabla A = \frac{\partial A}{\partial R}\hat{a}_R + \frac{1}{R}\frac{\partial A}{\partial \theta}\hat{a}_\theta + \frac{1}{R\sin\theta}\frac{\partial A}{\partial \phi}\hat{a}_\phi$

Curl

Cartesian: $\nabla \times \overline{A} = (\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z})\hat{a}_x + (\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x})\hat{a}_y + (\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y})\hat{a}_z$

Cylindrical: $\nabla \times \overline{A} = (\frac{1}{r}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z})\hat{a}_r + (\frac{\partial A_r}{\partial z} - \frac{\partial A_z}{\partial r})\hat{a}_\phi + \frac{1}{r}(\frac{\partial}{\partial r}(rA_\phi) - \frac{\partial A_r}{\partial \phi})\hat{a}_z$

Spherical:

$$\nabla \times \overline{A} = \frac{1}{R\sin\theta}(\frac{\partial}{\partial \theta}(A_\phi \sin\theta) - \frac{\partial A_\theta}{\partial \phi})\hat{a}_R + \frac{1}{R}(\frac{1}{\sin\theta}\frac{\partial A_R}{\partial \phi} - \frac{\partial}{\partial R}(RA_\phi))\hat{a}_\theta + \frac{1}{R}(\frac{\partial}{\partial R}(RA_\theta) - \frac{\partial A_R}{\partial \theta})\hat{a}_\phi$$

Laplacian

Cartesian: $\nabla^2 A = \frac{\partial^2 A}{\partial x^2} + \frac{\partial^2 A}{\partial y^2} + \frac{\partial^2 A}{\partial z^2}$

Cylindrical: $\nabla^2 A = \frac{1}{r}\frac{\partial}{\partial r}(r\frac{\partial A}{\partial r}) + \frac{1}{r^2}\frac{\partial^2 A}{\partial \phi^2} + \frac{\partial^2 A}{\partial z^2}$

Spherical: $\nabla^2 A = \frac{1}{R^2}\frac{\partial}{\partial R}(R^2\frac{\partial A}{\partial R}) + \frac{1}{R^2\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\frac{\partial A}{\partial \theta}) + \frac{1}{R^2\sin^2\theta}\frac{\partial^2 A}{\partial \phi^2}$

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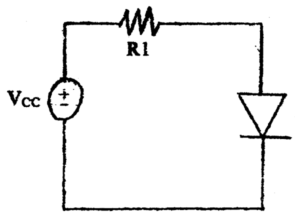
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BEI, BCT	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

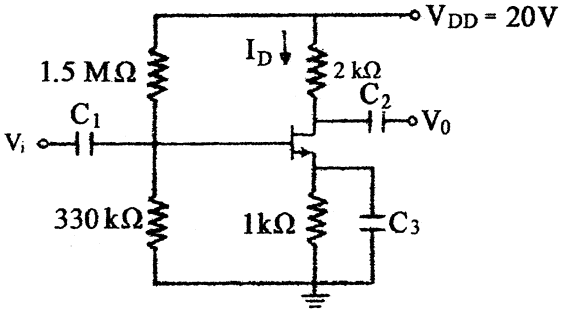
Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What is Dc load line? Find operating point for the diode circuit graphically using load line method. [1+4]
2. In the circuit given below the DC power supply V_{CC} = 10 V is superimposed with 60 Hz sinusoid of 1 V peak to peak amplitude. Calculate the amplitude of the sine wave signal appearing across the diode for the case R1 = 10 KΩ. Assume the constant voltage drop of 0.7 V in the diode. [5]



3. Why voltage divider biasing called β independent? Design common emitter Amplifier using β independent dc biasing method with appropriate guideline. Given parameters: V_{CC} = 24 VDC, I_C = 1.5 mA, β = 150. [1+4+2+2]
4. What is the significance of bypass capacitor in CE amplifier? Draw the small signal model of voltage divider bias for emitter bypassed capacitor CE amplifier circuit and find its input impedance, output impedance and voltage gain. [2+6]
5. Explain construction and working principle of N channel Depletion type MOSFET with the help of drain characteristics and transfer characteristics. [8]
6. Find I_D and V_{DS} for the given circuit. Given data are V_P = - 5.5 V, I_{DSS} = 10 mA and assume all the capacitors are ideal and check whether transistor is operating in pinch off region or not? [8]



7. Draw the circuit diagram of class B push-pull amplifier. Derive its general efficiency and maximum efficiency. [8]
8. Draw the circuit diagram of class A series fed amplifier and its corresponding characteristic graph. And, find its general efficiency. [3+4]
9. Draw the circuit diagram of op-amp Wein Bridge oscillator. Derive its frequency of oscillation. [2+4]
10. Draw the circuit diagram of Hartley oscillator. Derive its frequency of oscillation. [6]
11. Design DC voltage regulator using LM 317 to get 6-15V output. [6]
12. Draw standard series DC voltage regulator circuit and find its voltage stability factor (S_v). [4]

TRIBHUVAN UNIVERSITY
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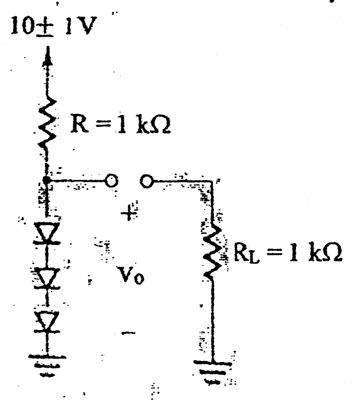
Examination Control Division
2079 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BEI, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronics Devices and Circuits (*EX 501*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. A string of three diodes is used to provide a constant voltage of about 2.1 v. Calculate the change in this regulated voltage caused by (i) a $\pm10\%$ change in the power supply voltage; (ii) connection of a 1K Ω load resistance. Assume $\eta = 2$. [3+2]

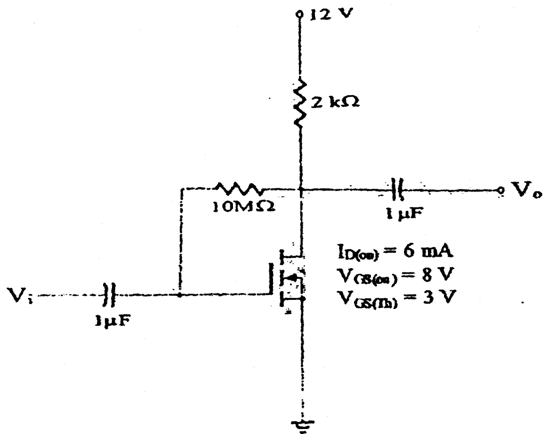


2. A zener diode exhibits a constant voltage of 5.6 V for currents greater than five times the knee current. I_{zk} is specified to be 1mA. The zener is to be used in the design of a shunt regulator fed from a 15V supply. The load current varies over the range of 0 mA to 15 mA. Find a suitable value for the resistor R. What is the maximum power dissipation of the zener diode? [3+2]

3. Design voltage divider CE amplifier (without emitter by pass capacitor). Given: Transistor BC 547B having $\beta = 295$, $I_c = 1.5$ mA and Vcc = +9V.
   a) Is this the best Q point? Why?
   b) Calculate its input impedance and voltage gain.
   c) What is the maximum peak voltage of the signal that can be applied to the input of this amplifier to ensure the transistor is always in active region? [5+2+3+2]

4. Draw Ebers- Moll (EM) model of BJT and write expression of collector current for active region. [5]

5. Find Q point and show it graphically. [6+2]



6. Explain the working of n channel DMOSFET with characteristics curves. Derive an expression for JFET transconductance. [6+3]

7. It is required to design a class B power Amplifier to deliver an average power of 20 W to an 8 Ω load. The power supply is to be selected such that Vcc is about 5 V greater than the peak output voltage. This avoide transistor saturation and associated nonlinear distortion, and allows for including short circuit protection circuitry. Determine the supply voltage required, the peak current drawn from each supply, the total supply power, and the power conversion efficiency. Also determine the maximum power that each transistor must be able to dissipate safely. [1+1+2+2]

8. Derive general efficiency of series fed Class A power amplifier. [6]

9. Explain the working principle of crystal oscillator with diagráms operating in both parallel and series resonance mode. [4+2+2]

10. State Barkhausen Criteria for sinusoidal oscillation. Is it possible to obtain 50% duty cycle square wave from 555 timer Astable Multivibrator? How? [2+3]

11. Explain the working of transistor series voltage regulator with current limiting element. [6]

12. Design variable DC voltage regulator using LM 317 to get (5-9) volts output. [5]

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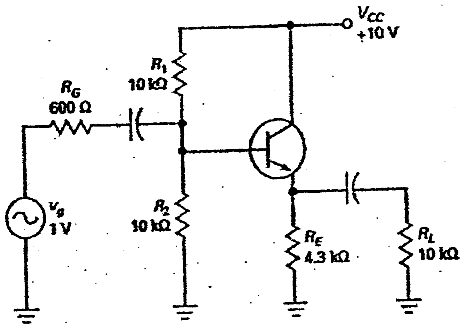
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BEI, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

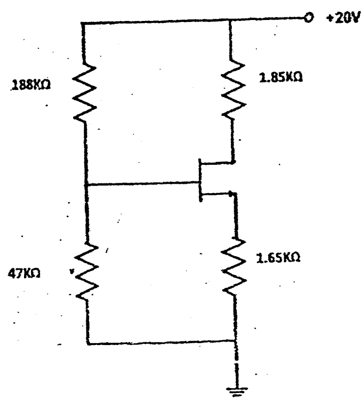
Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Explain the reverse break down region in zener diode. "Zener diode acts as a voltage reference element" Justify the statement from IV characteristic curve. [5]
2. A diode conducts 1mA at 20°C. If it is operated at 100°C, what will be its current? Given data are $\eta = 1.6$ and negative temperature coefficient value = -2.2 mV/°C. [5]
3. Show the importance of transistor bias stabilization. Design voltage divider bias (common collector configuration) to get $I_{CQ} = 1.5$ mA. Assume power supply voltage VCC = 15V and beta of transistor is 110. [3+5]
4. Why BJT is called bipolar and FET is called unipolar device? Derive mathematically the transconductance of MOSFET. [2+3]
5. The bipolar junction transistor parameters for the circuit in figure below are $\beta = 200$ and $V_A = \infty$. Determine the input resistance, output resistance and overall voltage gain of the circuit. [8]



6. Describe the physical structure of N-channel JFET and explain its working principal and characteristics clearly marking the various regions of operation. [2+6]
7. Find the drain current (I_D) and drain to source voltage (V_{DS}) for the following circuit. Given parameters are: $V_t = 1$ V and $k = 0.5$ mA/V^2. [8]



8. Draw the circuit diagram of transformer coupled class B push-pull amplifier stage. And find its maximum efficiency. Define cross over distortion in class B amplifier. [2+4+2]

9. Draw the circuit diagram of Quasi complementary-symmetry class AB amplifier using diodes. [3]

10. When are tuned amplifiers used? Draw the circuit diagram of class-A tuned amplifier and its frequency response graph. [2+3]

11. Draw Wien Bridge oscillator circuit and derive the expression for frequency of oscillation and gain of amplifier circuit. [1+3+2]

12. Describe the operation of precision half wave rectifier with circuit diagram. [4]

13. Why transistor series regulator has lower efficiency? Explain the operation of voltage regulator using band gap voltage reference. [2+5]

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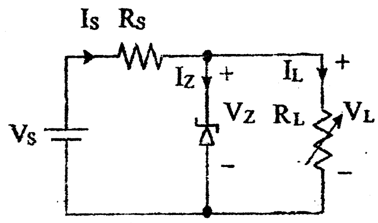
TRIBHUVAN UNIVERSITY	Exam.	Back		
INSTITUTE OF ENGINEERING	Level	BE	Full Marks	80
Examination Control Division	Programme	BEL, BEX, BEI, BCT	Pass Marks	32
2078 Kartik	Year / Part	II / I	Time	3 hrs.

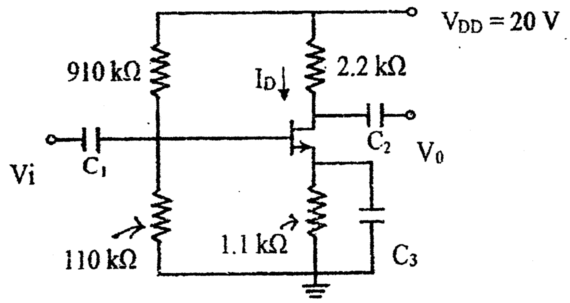
Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain the small signal model of PN junction diode and derive the expression for its dynamic resistance. [5]
2. Determine the Range of load R_L that will maintain the zener diode load voltage V_L at 5V. Given $V_S = 10$ V, $R_S = 100\ \Omega$, $I_{ZM} = 30$ mA. [5]



3. Design a voltage divider type dc biased CE amplifier to obtain β independent biasing. Use appropriate guidelines to support your design. Given $V_{CC} = 12$ V DC, $I_C = 2$mA and $\beta = 150$. [7]
4. Derive the expression for R_{in}, R_{out}, A_v and A_i in CE capacitor bypassed amplifier. [8]
5. Describe the construction and working principle of EMOSFET with the help of drain characteristics curve and mathematical expressions. [8]
6. Find I_D and V_{DS} for the given circuit. Given data are $V_P = -3.5$V, $I_{DSS} = 10$ mA and assume all the capacitors are ideal and check whether transistor is operating in pinch off region or not? [7]



7. Draw the circuit diagram of transformer coupled class B push-pull amplifier and show that the maximum efficiency is 25π %. [7]
8. When are tuned amplifiers used? Draw class A tuned amplifier circuit and find its 3 dB bandwidth. [7]
9. Explain working of RC phase shift oscillators and derive the frequency of its oscillation. [6]
10. Draw standard series DC voltage regulator circuit and find its voltage stability factor (Sv). [6]
11. Design a voltage regulator to give output voltage from 7V to 21V using LM317. [5]
12. Write short notes on: [3×3]

    a) Ebers Moll model
    b) Transconductance of JFET
    c) Crossover distortion

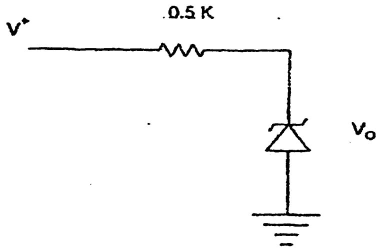
TRIBHUVAN UNIVERSITY INSTITUTE OF ENGINEERING **Examination Control Division** **2076 Chaitra**	**Exam.**	**Regular**		
	Level	BE	**Full Marks**	80
	Programme	BEL, BEX, BEI, BCT	**Pass Marks**	32
	Year / Part	II / I	**Time**	3 hrs.

Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define Q-point in pn junction diode operation. Show it graphically with necessary derivations. Differentiate between avalanche and zener break down. [3+2]

2. The 6.8 V zener diode is specified to have $V_Z = 6.8$ V at $I_Z = 5$ mA, $r_Z = 20\Omega$ and $I_{ZK} = 0.2$ mA. The supply voltage V^+ is nominally 10V but can vary by $\pm$ 1V. Find V_0 with no load and with V^+ at its nominal value. Find the change in V_0 resulting from connecting a load resistance RL that draws a current $I_L = 1$ mA. What is the minimum value of R_L for which the diode still operates in the breakdown region? [2+1+2]



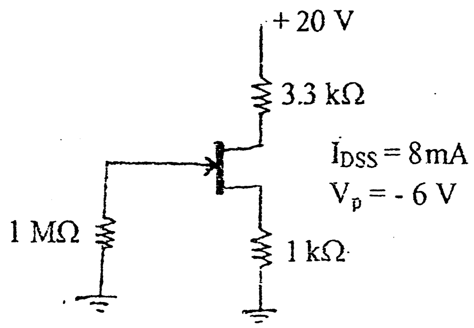
3. Design β independent type dc biased common collector amplifier, and find its current gain and input resistance. Given parameters: $V_{CC} = 20$ VDC, $I_C = 2$mA and $\beta = 100$ and use firm biasing method. [8]

4. Draw common emitter transistor amplifier circuit (emitter bias with unbypassed emitter capacitor) and find its output impedance and voltage gain. Write application of common base amplifier. [4+3+1]

5. Describe the working principle of N-channel Depletion type MOSFET with the help of I_D Vs V_{DS} characteristics and transfer characteristics curves. Find the condition and expression for it to operate in active mode of operation and write the expression for drain current. [5+2+1]

6. Write about JFET as a voltage controlled resistor with practical application. [4]

7. Find I_{DQ} and V_{GSQ} from the following circuit. [5]



8. Draw the circuit diagram of class A series fed amplifier and its corresponding characteristic graph. And, find its general efficiency. [3+3]

9. Draw the circuit diagram of Complementary-Symmetry class-AB amplifier using Darlington pair transistors. [3]

10. Describe about tuned amplifier and derive the expression for the 3dB bandwidth of the amplifier. [5]

11. Differentiate between synchronous and stagger turned amplifier. [3]

12. Draw voltage controlled oscillator circuit using IC 555 and derive expression for frequency of oscillation. [6]

13. Among Hartley and Colpitts LC oscillator, which one do you choose to implement in FM stations to generate carrier wave signal? Why? Draw its circuit diagram. [5]

14. Draw the standard series DC voltage regulator circuit and find its voltage stability factor(S_v). [5]

15. Design a 5V to 20V variable dc voltage regulator using IC LM317. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

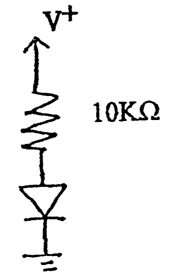
Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Differentiate between avalanche and zener breakdown. Draw V-I characteristic curve of zener diode and briefly explain about it. [3+2]

2. In the given circuit, the power supply V^+ has a dc value of 10V on which is super imposed a 50 Hz sinusoid of 1V peak amplitude. Calculate both the dc voltage of the diode and amplitude of the sine-wave signal appearing across it. Assume the diode to have a 0.7V at 1 mA current and η=2. [5]



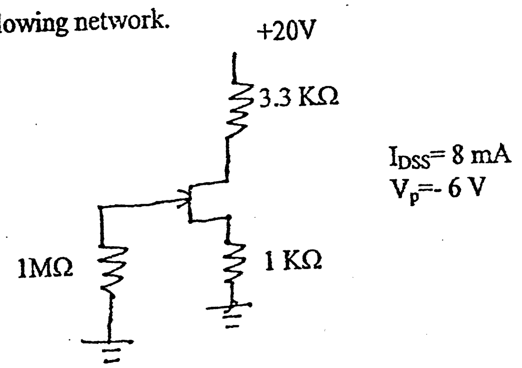
3. Design β independent type of dc biased common collector amplifier, and find its voltage gain and input resistance. Given parameters: V_{cc}= 20 VDC, I_c=2mA and β=100 and use firm biasing method. [8]

4. Describe in brief the operation of BJT as a switch in cut off and saturation region. [4]

5. Explain about working principle of N-channel DMOSFET with its construction, characteristics curves and characteristic equation. [7]

6. For the faithful amplification of signal, selection of operating point is utmost importance. Justify the above statement. Derive transconductance of bipolar junction transistor. [3+4]

7. Determine Q point for the following network. [7]



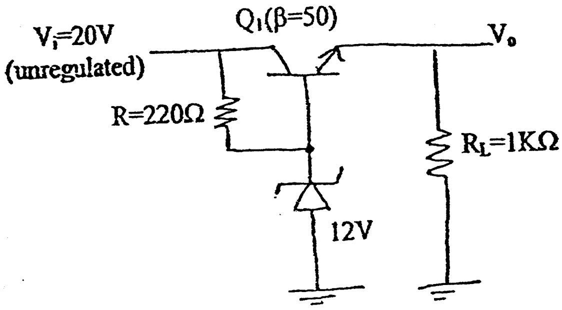
8. Draw the circuit diagram of the Hartley Oscillator and derive its frequency of oscillation. [6]

9. Draw the circuit diagram of class A series fed amplifier and its corresponding characteristics graph. And find its general efficiency. [3+3]

10. Explain about the operation of voltage controlled oscillator (VCO) using 555 timer IC and derive its frequency of oscillation. [8]

11. Draw the circuit diagram of Complementary-Symmetry Class-AB amplifier using Darlington pair transistors. [3]

12. Calculate the output voltage and the zener current in the regular circuit as shown in figure below for R_L=1 KΩ and R=220Ω. V_Z=12V. [5]



13. Draw series voltage regulator with current limiting circuit and explain how this protection circuit works? [6]

14. Briefly explain about Precision half wave rectifier with circuit diagram. [3]

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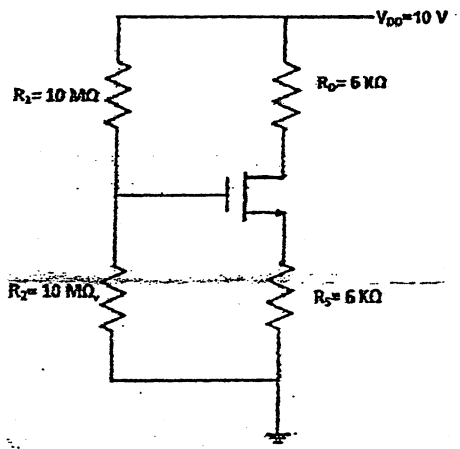
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Find the operating point of the diode circuit graphically using load line method. [5]
2. Design DC voltage regulator for 6V output. Given data are V_Z=6V at I_z=20mA, I_{zk}=2mA, P_{zmax}=500mW and rz=10Ω. The nominal input voltage is 15V+30% DC. Find the maximum current it can deliver to the load. [5]
3. Design a common base amplifier circuit using β independent method. Given parameters are V_{cc}=15V, I_E=1.5mA, β=100 and input and output impedances are comparatively large. Use appropriate guideline to support your design. [7]
4. Why common collector amplifier is known as emitter follower? Draw its ac equivalent circuit to find its input resistance and voltage gain. [1+6]
5. Draw and describe the Ebers Moll model for BJT. [4]
6. Draw the cirucuit diagram of the Colpitts Oscillator and derive its frequency of Oscillation. [6]
7. Find the drain current (I_D) and drain to source voltage (V_{DS}) for the following circuit. Given parameters are: V_t=1 V and k=0.5 mA/V^2. [7]



8. Describe the construction and working principal of N-channel JFET with the help of characteristics curve and mathematical expression. [7]

9. Define crossover distortion in class B amplifier. Draw quasi-complementary symmetry class AB amplifier. And explain how crossover distortion is eliminated in class AB amplifier. [7]

10. Draw the circuit diagram of Class A tuned amplifier and determine the range of frequency in which it gives maximum gain within 3 dB range? [6]

11. Design a DC voltage regulator for 3V to 12V output using LM317. [5]

12. Define the term multivibrator. Explain the operation of op-amp based astable multivibrator for square wave with the help of circuit diagram and waveforms and also determine its frequency of oscillation. [8]

13. Draw the standard series DC voltage regulator circuit and find its voltage stability factor(S_v). [6]

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16 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

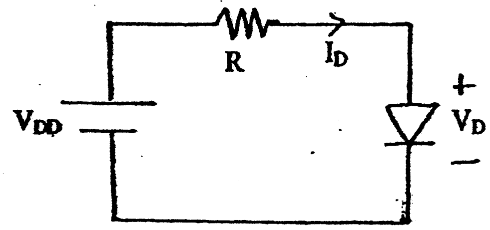
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX, BCT, BEL	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

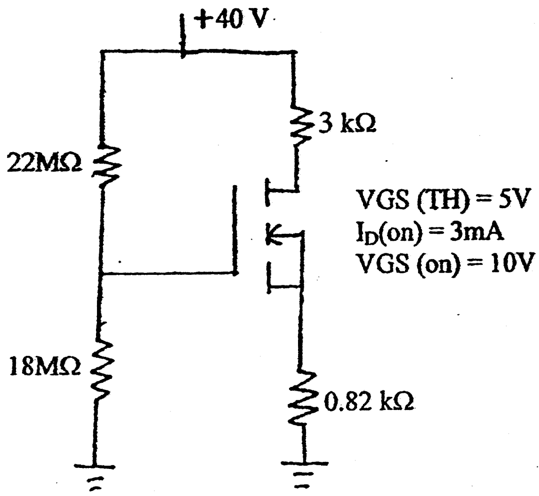
Subject: - Electronic Devices and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. Derive the expression for dynamic resistance of pn junction diode. [5]
2. Determine the current I_D and the diode voltage V_D with V_{DD}=5 V and R= 1KΩ. Assume that the diode has a current of 1 mA at a voltage of 0.7 V and that its voltage drop changes by 0.1 V for every decade change in current. [5]



3. Design voltage divider biased common emitter BJT amplifier to get voltage gain of -90. Assume β= 100 and Vcc=+12V. [8]
4. Derive input impedance, output impedance and voltage gain of common collector BJT amplifier. [8]
5. Explain the construction and operation of E-MOSFET with characteristics curve and mathematical expression. [7]
6. Derive mathematical definition of JEFET transconductance. [4]
7. Find I_{DQ} and V_{DSQ} from the following circuit. Show Q point graphically. [5+3]



8. Derive general efficiency of class B amplifier. [5]

9. Draw the circuit diagram of Darlington complementary-symmetry class AB amplifier using diodes. [3]

10. Derive maximum efficiency of transformer coupled class A amplifier. [5]

11. Draw astable multivibrator circuit using IC 555 and derive expression for frequency of oscillation. [6]

12. Explain working principle of RC phase shift oscillator with necessary expressions and circuit diagram. [6]

13. Explain the operation of voltage regulator using band gap voltage reference. [6]

14. Design a (5-15)V variable dc voltage regulator using LM 317 IC. [4]

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16 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

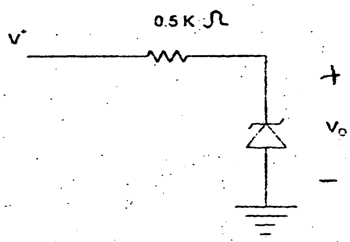
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX501)*

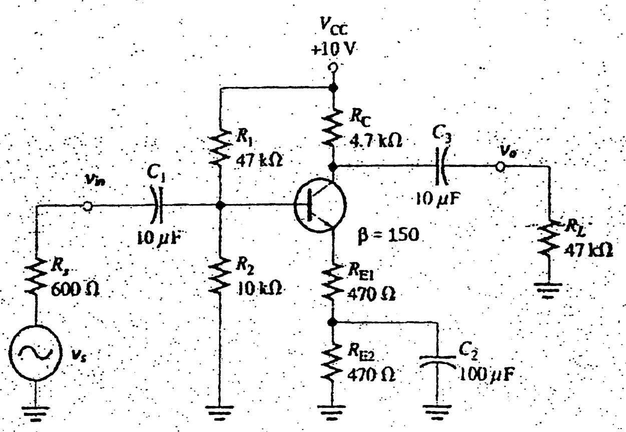
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. The leakage current of a silicon diode is $I_S = 10^{-9}$ A at 25°C, and the emission coefficient is $\eta = 1.6$. The operating junction temperature is $T_j = 60$°C. Determine (i) the leakage current I_S and (ii) the diode current I_D at $V_D = 0.8$ V. [4]

2. The 6.8V zener diode is specified to have $V_Z = 6.8$ V at $I_Z = 5$ mA, $r_z = 20\ \Omega$ and $I_{zk} = 0.2$ mA. The supply Voltage V^+ is nominally 10 V but can vary by ± 1V. Find V_0 with no load and with V^+ at its nominal value. Find the change in V_0 resulting from connecting a load resistance R_L that draws a current $I_L = 1$ mA. What is the minimum value of R_L for which the diode still operates in the breakdown region? [2+2+2]



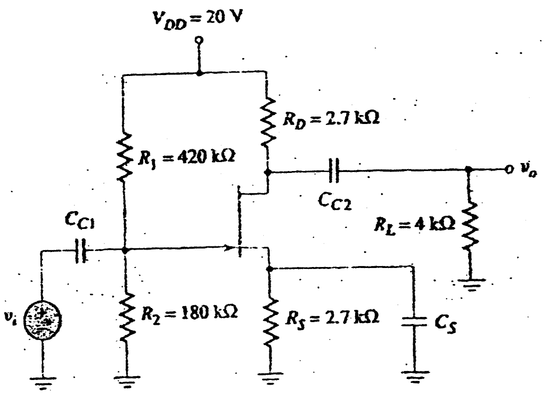
3. Determine the input resistance, output resistance and overall voltage gain of the circuit given below: [8]



4. Find terminal currents of BJT using Ebers-Moll Model. Write applications of different BJT configurations. [5+3]

5. Explain the construction and operation of D-MOSFET with characteristics curve and mathematical expression. [8]

6. Find the DC operating point of JFET circuit given below. Given parameters I_{DSS} = 12 mA and V_P = -4V. [8]



7. Derive maximum efficiency of series fed class A amplifier. [6]

8. Derive bandwidth of tuned amplifier. Write its applications. [6]

9. For a class B amplifier providing a 14V peak signal to 16 Ω load and a power supply of V_{cc} = 24V, determine input power, output power and circuit efficiency. [4]

10. Draw voltage controlled oscillator circuit using IC 555 and derive expression for frequency of oscillation. [6]

11. Draw the circuit diagram of half wave precision rectifier and explain the operation. [4]

12. Define voltage regulator. Explain the series voltage regulator with current limiting element. [1+5]

13. Explain working principle of WIEN BRIDGE oscillator with necessary expressions and circuit diagram. [6]

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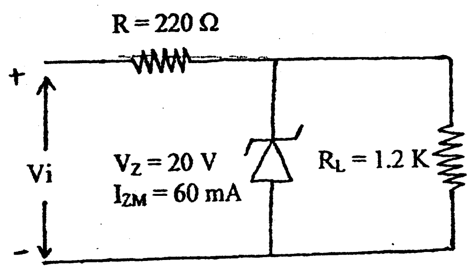
26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

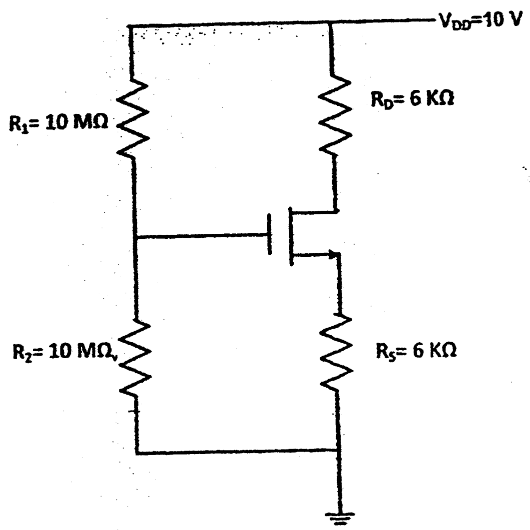
Subject: **- Electronic Device and Circuits *(EX501)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Scientific Calculator is allowed.*
- ✓ *Assume suitable data if necessary.*

1. Explain the small signal model of PN junction diode and drive its dynamic resistance. [2+4]
2. Determine the range of values of V_i that will maintain the Zener diode of figure below in ON state. [5]



3. Design β independent type DC biased common emitter amplifier with emitter resistance bypassed and find its voltage gain and input resistance. Given parameters V_{cc} = 24, I_C = 2 mA, β = 90. Use appropriate guideline to have high input resistance. [8]
4. Describe in brief the operation of BJT as a switch in cut off and saturation region. [6]
5. Define transconductance (g_m). Derive g_m for BJT. [1+3]
6. Explain the construction and operation of N channel enhancement type MOSFET with the help of drain characteristics and transfer characteristics. [8]
7. Find the drain current (I_D) and drain to source voltage (V_{DS}) for the following circuit. Given parameters are: V_t = 1 V and k = 0.5mA/V^2. [6]



8. State the difference between BJT and FET. [2]

9. What is crossover distortion? Explain how it can be eliminated with necessary diagram. [2+4]

10. Draw the circuit diagram of tuned amplifier and derive the expression for the 3dB bandwidth of the amplifier. [6]

11. Define Barkhausen criteria for sinusoidal oscillation. Draw the circuit diagram of wien bridge oscillator and determine its frequency of oscillation. [2+6]

12. Describe Colpitt's oscillator with necessary circuit diagram. [5]

13. Draw the standard series DC voltage regulator circuit and find its voltage stability factor (S_V). [6]

14. Design a 3.7 to 9V variable dc voltage regulator using IC LM317. [4]

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6

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

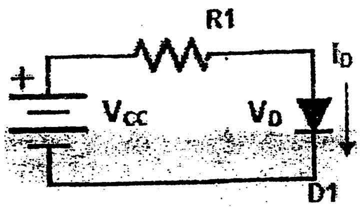
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL,BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Device and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Scientific calculator is allowed.*
- ✓ *Assume suitable data if necessary.*

1. In the circuit given below, the DC power supply $V_{cc} = 10$ V is superimposed with 60 Hz sinusoid of 1 V_{pp} amplitude. Calculate the amplitude of the sine wave signal appearing across the diode for the case R1 = 10 KΩ. Assume the constant voltage drop of 0.7 V in the diode. [5]



2. Define and explain reverse breakdown effect. Describe how Zener diode works as a voltage regulator. [2+3]

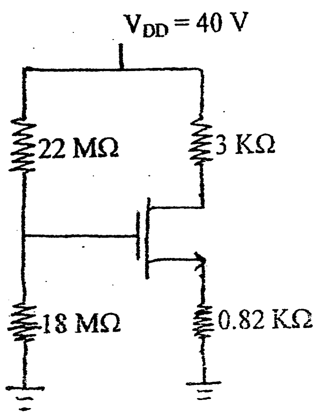
3. Why voltage divider biasing is called β independent? Design CE amplifier using β independent dc biasing method with appropriate guideline. [3+5]

   Given: $V_{CC} = 24$ V, $I_{BQ} = 10\mu A$ and $\beta = 100$

4. What is the significance of bypass capacitor in CE amplifier? Draw the small signal model for capacitor bypassed CE amplifier circuit and find its input impedance, output impedance and voltage gain. [2+6]

5. Describe the principle of operation of operation of N channel Depletion type MOSFET with the help of mathematical expression and drain characteristics graphs. [8]

6. Determine I_D and V_{DS} for the given circuit and find the region of its operation. Given: $k = 0.12 mA/V^2$ and $V_t = 5$ V. [6+2]



7. Explain the operation of transformer coupled class B push-pull amplifier with the proper circuit diagram and characteristics curve. Also determine its maximum efficiency. [4+4]

8. Explain why class A amplifier is cooler with load than without load. [6]

9. State Barkhausen criteria. Draw the circuit diagram of RC phase shift oscillator and derive the expression for its frequency of oscillation. [2+5]

10. Describe the operation of precision half wave rectifier with circuit diagram. [5]

11. Describe the operation of a series voltage regulator with current limiting circuit. [7]

12. Design a 5.2 V to 13 V variable DC voltage regulator using IC LM 317. [5]

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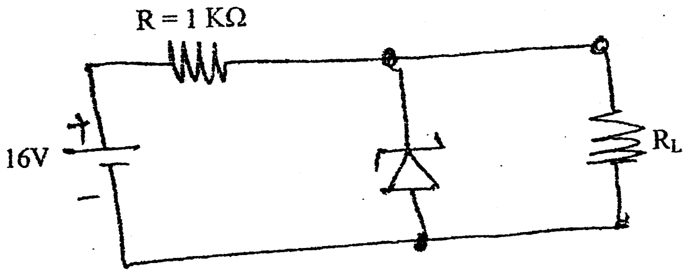
25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Electronic Devices and Circuits *(EX501)*

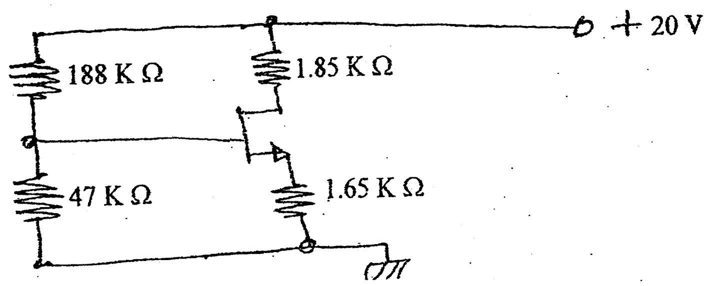
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Find operating point for the diode circuit graphically using load line method. [4]
2. Find the zener current form the given circuit if (i) $R_L = 1.2\ K\Omega$ (ii) $R_L = 3\ K\Omega$ [4]



$P_{zM} = 80\ mW$
$V_z = 10\ V$

3. Determine the input resistance and output resistance of CC BJT amplifier circuit. Why common collector configuration is used in amplifier circuit design. [2+2+2+2]
4. Describe the operation of BJT as switch with the help of Non-gate circuit. [4]
5. Derive expressions to obtain transconductance for BJT, JFET and MOSFET. Also prove that $\gamma_\pi = (\beta+1)\gamma_e$ [8]
6. The n-channel JFET in the figure below has I_{DSS} = 18 mA and V_p = -5V. Determine the values of I_D and V_{DS}. [8]



7. Describe the working principle of N-channel EMOSFET with the help of its drain characteristics curve and necessary mathematical expressions. [6]

8. Determine the general efficiency of transformer coupled class B push pull amplifier. Draw the circuit diagram and its graph. [4+4]

9. Explain how class AB amplifier eliminates the cross over distortion. [3]

10. Draw the circuit diagram of LRC tuned class A amplifier and its frequency response graph and show that Bandwidth = $\frac{1}{RC}$. [3+3]

11. Explain the operation of AMV using 555 timer IC and derive its frequency of oscillation. [6]

12. Draw the circuit diagram of Hartley oscillator. [3]

13. Draw standard dcV regulator circuit and find its voltage stability factor. [4+4]

14. Design a DCV regulator for 3.7 V to 12 V output using LM317. [4]

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20 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

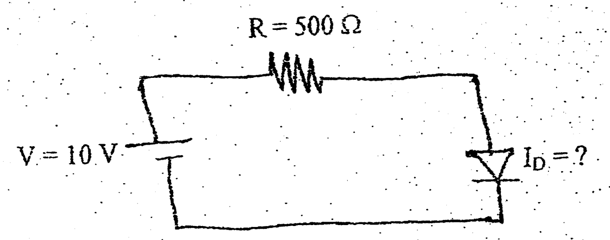
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. In the given circuit, the diode used has its n = 1.74 and it conducts 1mA at forward bias voltage of 0.7 V. Find the current flow in the circuit. [4]



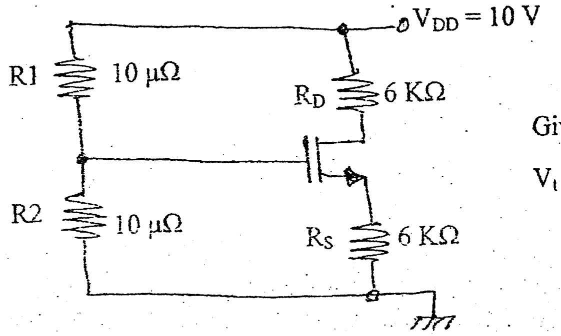
2. Design DC voltage regulator for 6V output. Given data are V_z = 6 V at I_Z = 20 mA, I_{zk} = 2mA, P_{Zmax} = 500 mw and r_Z = 10Ω. The nominal input voltage is 15V ± 30% DC. Find maximum current it can delivers to the load. [4]

3. Design β independent type dc biased common collector amplifier and find its current gain and input resistance. Given parameters are: V_{CC} = 20 V, I_C = 2 mA and β = 100. Use firm biasing method. [8]

4. Draw the small signal model circuit for capacitor unbypassed CE amplifier and find its voltage gain and current gain. [8]

5. Describe the construction and working principle of N-channel JFET with the help of its drain characteristics curve and necessary mathematical expressions. [6]

6. For the circuit given below, find I_D and V_{DS}. Also determine its region of operation and small signal ac equivalent circuit. [3+3+2+2]



Given data are:

$V_t = 1$ V, $k = 0.5 \frac{mA}{V^2}$

7. Draw the circuit diagram of transformer coupled class B push pull amplifier and its corresponding characteristic graph. And from graph prove that maximum efficiency is equal to 78.5%. Also find the condition when it has maximum loss. [3+3+3+3]

8. Draw the circuit diagram and its frequency response graph of LRC tuned class A amplifier. State its resonance frequency and band width (3dB). [1+1+1+1]

9. State Barkhausen criteria for sinusoidal oscillator. Is this principle applicable to RC oscillator using op-Amp? Why? If yes, determine the frequency of oscillations and the gain of the amplifier of the circuit. [2+1+4]

10. Explain the operation of AMV using555 IC and derive its frequency of oscillation. [6]

11. Describe the bandgap voltage reference source with the help of a relevant circuit. Compare bandgap voltage reference source with zener diode. [4+2]

12. Draw the series dc voltage regulator with current limiting element and explain how it works. [5]

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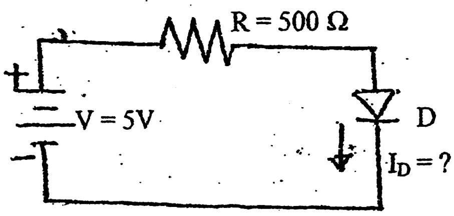
26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

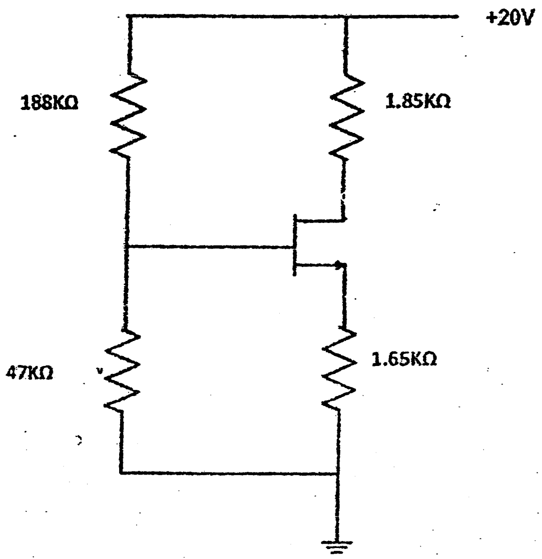
Subject: - Electronic Devices and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. In the given circuit, the diode used has its n = 1.74 and it conducts 1mA at forward bias voltage of 0.7 V. Find the current flow in the circuit. [6]



2. Draw unregulated dc voltage power supply using bridge rectifier. [2]
3. Describe functions of BJT as amplifier with the help of transfer characteristics (i_c - v_{BE} graph), and find expressions for g_m, r_π and r_e. Also show that $\beta = g_m r_\pi$ and $r_\pi = (\beta+1) r_e$. [6+2]
4. Draw common collector transistor amplifier circuit and find its input impedance, output impedance and voltage gain. [6]
5. Describe the construction and working principal of EMOSFET with the help of drain characteristics curve and mathematical expression. [6]
6. The n-channel JFET in the figure below has I_{DSS} = 18mA and V_P = -5V. Determine the values of I_D and V_{DS}. [8]



7. Describe the operation of class B amplifier and find the maximum efficiency of the amplifier. [4+4]

8. Draw class A tuned amplifier and its corresponding graph. And find its resonant frequency (ω_o) and 3dB band width (B). [6]

9. Describe AMV circuit using IC 555 and state its frequency of oscillation. [6]

10. Draw phase shift oscillator circuit and write its frequency of oscillation (f_o). [5]

11. Why transistor series regulator has lower efficiency? Explain the operation of voltage regulator using band gap voltage reference. [2+4]

12. Design a (5-10)V variable dc voltage regulator using LM 317 IC. [5]

13. Write short notes on: (any two) [2×4]

    a) Π-models of BJT and MOSFET
    b) ac equivalent circuit of common source amplifier using MOSFET
    c) BJT as switch

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25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Describe with the help of loadline and IV characteristics of the diode, a simple circuit that uses pn junction diode in forward biased state. [5]
2. Design DC voltage regulator for 6V output. Given data are $V_Z = 6V$ at $I_Z = 20$ mA, $I_{zk} = 2$ mA, $P_{ZMAX} = 500$ mW and $r_z = 20\Omega$. The nominal input voltage is 12v±20% DC. Find its voltage regulation factor and maximum current it can deliver to the load. [5]
3. Design Common Base Amplifier using β-independent dc biasing method. Use appropriate guideline to support your design. Given parameters are: V_{CC} = 24VDC, I_C = 1 mA and $\beta = 200$. Also find its voltage gain by using its ac equvalent circuit. [5+3]
4. Describe in brief the operation of BJT as switch in cut off and saturation region. [4]
5. Draw Ebers Moll model, low frequency Π-model and simple T - model for BJT. [2+1+1]
6. Describe the principle of operation of N-channel JEET with the help of drain and transfer characteristics graphs and mathematical expressions. [8]
7. An n-channel JEET has a pinch-off voltage of -4.5V and I_{DSS} = 9 mA. At what value of V_{GS} will I_{DS} be equal to 3 mA? What is its g_m at this I_{DS}. [5]
8. Derive an expression to obtain transconductance of MOSFET. [3]
9. What is crossover distortion and how it can be eliminated? [4]
10. Draw a circuit diagram of tuned amplifier. Determine the range of frequency in which it gives maximum gain within -3dB range. [5]
11. Why the efficiency of class-A amplifier is low? Obtain the expression of the general efficiency of series fed class -A power amplifier circuit. [6]
12. Define Barkhausen Criteria for sinusoidal oscillation. Draw the circuit diagram of RC phase shift oscillator and derive its frequency of oscillation. [5]
13. Define the term multivibrator. Explain the operation of op-amp based astable multivibrator with the help of circuit diagram and waveform. [4]
14. Design a regulator circuit to obtain 16 VDC. Choose approximate values of the parameters. Input voltage is 25 VDC. [5]
15. Draw the series voltage regulator with current limiting element and explain how it works. [6]
16. Draw block diagram for IC voltage regulator. [3]

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25 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

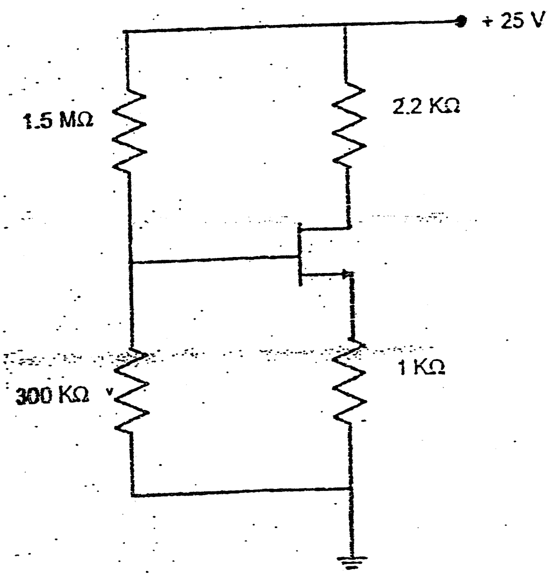
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL,BEX,BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electronic Devices and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. What is p-n junction diode? Explain the large signal models of p-n junction diode. [1+4]
2. Find the value of dynamic resistance if voltage in the diode is 650mv and I_{RS} is 10pA= $(10\times10^{-12}A)$ (Given n = 2 and V_1 = 25 mV) [5]
3. Why common collector amplifier is also called emitter follower? Draw the common collector transistor amplifier circuit and find its input impedance, output impedance and voltage gain. [8]
4. Draw and describe the Ebers Moll model for BJT. [4]
5. Describe in brief the operation of BJT as a switch in cut off and saturation region. [4]
6. Describe the construction and working principle of EMOSFET with help of drain characteristics curve and mathematical expressions. [8]
7. Find I_D and V_{DS} for the given circuit. The given data are V_p = -4V and I_{DSS} = 10mA [5]



8. Derive an expression to obtain the transconductance of JFET. [3]
9. What is the maximum efficiency of class B amplifier? State the condition when it occurs. [4]
10. When are tuned amplifiers used? Draw class A tuned amplifier circuit and find its 3db bandwidth. [2+5]

11. Draw the circuit diagram of Complementary-Symmetry Class-AB amplifier. Using Darlington pair transistors. [3]
12. Write the applications of tuned LC oscillators. Draw the Colpitt's oscillator circuit and derive the expression for frequency of oscillation. [6]
13. Draw AMV circuit using IC 555 or BJT. [4]
14. State Barkhausen Criteria for sine wave oscillator. [2]
15. Design a (10-25) V variable dc series voltage regulator using LM 317 IC. [5]
16. Draw the circuit of current limiting circuit in dc voltage regulator. [2]
17. Find voltage stability factor of series dc voltage regulator. [5]

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26 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

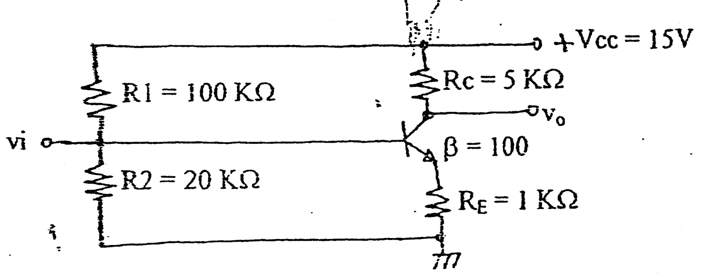
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

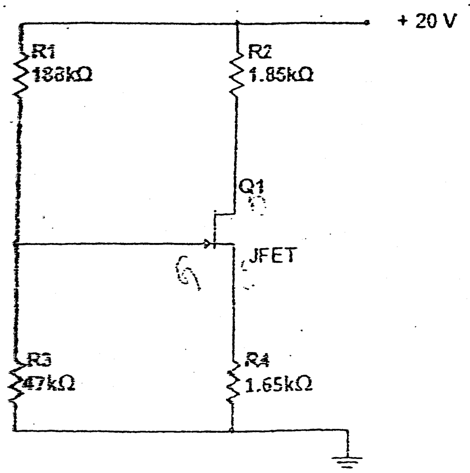
Subject: - Electronic Device and Circuits *(EX501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Draw full wave bridge rectifier circuit with 5 ohm load resistor connected at its output. If input ac voltage is 10V, calculate the power dissipation in the load resistor (Assume diodes operate at forward voltage of 0.7V). [4]
2. Explain the small signal model of PN junction diode and derive the expression for AC or dynamic resistance. [2+4]
3. Draw the ac equivalent circuit for given circuit and find its input and output resistances. Assume $\beta = 100$ for the BJT. [8]



4. Define transconductance (gm). Derive gm for BJT. [2+4]
5. Describe in brief the operation of BJT as a switch. [4]
6. Describe with necessary graphs and expressions the principle of operation of N-channel JFET. [6]
7. The n-channel JFET in the figure below has $I_{DSS} = 18$ mA and $V_P = -5V$. Determine the values of I_D and V_{DS}. [8]



8. State the difference between BJT and FET. [4]

9. Determine the general efficiency of Transformer Coupled Class-A power Amplifier. [6]

10. Draw the circuit diagram of Complementary-Symmetry Class-AB Amplifier. [2]

11. Calculate the efficiency of transformer coupled push pull Power Amplifier for a supply voltage of 20V and output of (i) $V_P = 20V$ (ii) $V_P = 16V$. [3+3]

12. Draw Wien Bridge Oscillator circuit and derive the expression for frequency of Oscillation and gain of the amplifier circuit. [2+3+3]

13. Draw standard series dc voltage regulator and find its voltage stability factor (S_v). [6]

14. Design a 4.2 V to 12 V variable dc voltage regulator using IC LM317. [4]

15. Draw the circuit diagram of square wave generator. [2]

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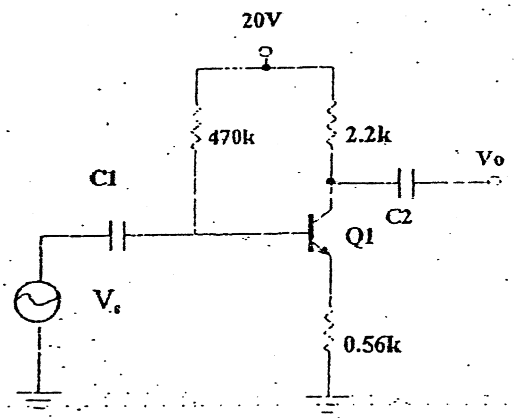
26 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

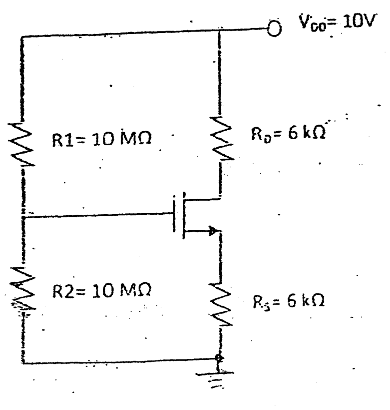
Subject: - Electronic Devices and Circuit *(Ex 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Explain the large signal models of PN junction diode. [4]
2. A diode conducts 1mA at 20°C. If it is operated at 100°C, what will be its current? Given data are: η=1.8 and negative temperature coefficient value = −1.8mv/°C. [4]
3. For the figure shown below with β = 120 find the a) input impedance (b) Output impedance (c) voltage gain (d) current gain. Use small signal model. [2+2+2+2]



4. Draw ac equivalent circuit of common collector amplifier. Find its input and output resistances. [2+3+3]
5. Describe the physical structural of N-channel JEET and explain its working principle and characteristics clearly marking the various regions of operation. [2+6]
6. Derive the expression to obtain the transconductance of E-MOSFET. [4]
7. Find the drain current (I_D) and drain to source voltage (V_{DS}) for the following circuit. Given parameters are: V_t = 1V and k = 0.5mA/V^2. [4]



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8. Draw the circuit diagram of class B push pull amplifier with output transformer and explain how push pull action is achieved. Determine the general efficiency of class B push pull amplifier. [1+3+4]

9. Draw class A tuned amplifier circuit and derive the expression for 3dB bandwidth of the amplifier. [2+6]

10. Describe the operation of IC 555 as square wave oscillator and find its frequency of oscillation. [6+2]

11. Estimate voltage stability factor (S_V) for standard series dc voltage regulator using BJT. Also, explain the operation of overload protection circuit that could be used in series voltage regulator circuit. [5+3]

12. A class B audio amplifier is providing 20V peak sine wave signal to 8Ω speaker with power supply of 25V (=V_{CC}). At what efficiency is it operating? [4]

13. Define and explain the reverse breakdown effect in diodes. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except BAR)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH 501)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt* ***All*** *questions.*
✓ *The figures in the margin indicate* ***Full Marks***.
✓ *Assume suitable data if necessary.*

1. Prove that $\begin{vmatrix} a^3 & 3a^2 & 3a & 1 \\ a^2 & a^2+2a & 2a+1 & 1 \\ a & 2a+1 & a+2 & 1 \\ 1 & 3 & 3 & 1 \end{vmatrix} = (a-1)^6$ by using properties of determinate. [5]

2. Define transpose of a matrix. Prove that the transpose of the product of two matrices is the product of their transpose taken in reverse order. [1+4]

3. Find the rank of the matrix $\begin{bmatrix} 1 & 0 & -5 & 6 \\ 3 & -2 & 1 & 2 \\ 3 & -2 & -9 & 14 \\ 4 & -2 & -4 & 8 \end{bmatrix}$ by reducing it into normal form. [5]

4. State Cayley-Hamilton Theorem. Use it to find the inverse of the matrix: [1+4]

$$\begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ 2 & -4 & -4 \end{bmatrix}$$

5. Prove that the line integral $\int_C \vec{F}.d\vec{r}$ of a continuous vector function $\vec{F}$ defined in a region R is independent of the path C joining any two points in R if and only if there exists a single valued scalar function ϕ, having first order partial derivatives such that $\vec{F} = \nabla\phi$. [5]

6. Evaluate $\iint_S \vec{F}.\vec{n}\, ds$ where $\vec{F} = y^2z^2\vec{i} + z^2x^2\vec{j} + x^2y^2\vec{k}$ and S is the surface of the sphere $x^2 + y^2 + z^2 = 1$ above the xy-plane. [5]

7. Apply Green's theorem in plane to evaluate, $\int_C \vec{F}.d\vec{r}$ where $\vec{F} = (x^2 - xy^3)\vec{i} + (y^2 - 2xy)\vec{j}$ and C is a square with vertices (0, 0), (2, 0), (2, 2), (0, 2). [5]

8. Verify the stroke's theorem for $\vec{F} = (x^2 + y^2)\vec{i} - 2xy\,\vec{j}$ taken round the rectangle bounded by the lines $x = \pm a$, $y = 0$, $y = b$. [5]

9. Define Laplace transform of function f(t). Find the Laplace transform of [1+2+2]

a) $te^{-4t}\sin 3t$ b) $\frac{1-e^{t}}{t}$

10. Find the inverse Laplace transform of: [2+3]

a) $\frac{s^2}{(s+2)^3}$ b) $\tan^{-1}\frac{2}{s}$

11. Solve the following initial value problem by using Laplace transform

$y'' + 2y' - 3y = \sin t,\ y(0) = y'(0) = 0.$ [5]

12. Find the Fourier series of the function $f(x) = \frac{(\pi - x)^2}{4}$ in the interval $0 \le x \le 2\pi$. [5]

13. Obtain the half-range Fourier cosine series of sinx in the interval $0 \le x \le \pi$. [5]

14. Solve the linear programming problem maximize by simplex method [7]

Maximize: $Z = 10x_1 + x_2 + 2x_3$
Subject to: $x_1 + x_2 - 2x_3 \le 10$
$4x_1 + x_2 + x_3 \le 20$
and $x_1, x_2, x_3 \ge 0$.

15. Solve the linear programming problem by simplex method using two phase method: [8]

Maximize $Z = 3x_1 - x_2$
Subject to $2x_1 + x_2 \ge 2$
$x_1 + 3x_2 \le 2$
$x_2 \le 4;\ x_1, x_2 \ge 0$.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	All (Except BAR)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III (*SH 501*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. Applying properties of determinant, prove that $\begin{vmatrix} a & b & a & a \\ a & b & b & b \\ b & b & b & a \\ a & a & b & a \end{vmatrix} = -(b-a)^4$. [5]

2. Prove that every square matrix can be uniquely expressed as the sum of symmetric and skew-symmetric matrices. [5]

3. Find the rank of the augmented matrix and test the consistency of the system of linear equations $x+9y-z = 27$, $x-8y+16z = 10$, $2x+y+15z = 37$. Also find the solution if the system is consistent. [5]

4. State Cayley-Hamilton theorem and use it to find the inverse of the matrix: [5]
$$\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$$

5. If $\vec{F} = 3x^2yz^2\vec{i} + x^3z^2\vec{j} + 2x^3yz\vec{k}$, show that $\int_C \vec{F}.d\vec{r}$ is independent of the path of integration. Hence evaluate the integral on any path C from P: (0,0,0) to Q: (1,2,3). [3+2]

6. Evaluate the flux of $\vec{F} = (x+y^2)\hat{i} - 2x\hat{j} + 2yz\hat{k}$ over the surface of the plane $2x + y + 2z = 6$ lying in the first octant. [5]

7. State and prove the Green's theorem in plane. [5]

8. State stoke's theorem. Apply it to evauate $\iint_S (\nabla \times \vec{F}) \cdot \vec{n}\, ds$ where $\vec{F} = (2x-y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$, S is the upper half surface of the sphere $x^2 + y^2 + z^2 = a^2$ and C is its boundary. [1+4]

9. Find the Laplace transform of: (i) Sinhat Cosbt (ii) $\frac{e^{-at} - e^{-bt}}{t}$ [5]

10. What do you mean by convolution of two functions f (t) and g(t)? Hence or otherwise find the inverse Laplace transform of $\frac{s^2}{(s^2+4)(s^2+9)}$ [1+4]

11. Using laplace transform, solve the initial value problem: $y'' + 2y' + 2y = 5\sin x$, $y(0) = y'(0) = 0$. [5]

12. Find the Fourier series to represent $f(x) = x - x^2$ from $-\pi$ to π and deduce that: [5]
$$\frac{\pi^2}{12} = \frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots$$

13. Find half range sine as well as cosine series for $f(x) = e^x$ in (0,2). [2+3]

14. Solve the following LPP by the simplex method: [7]

Maximize, $P = -x_1+2x_2$

Subject to:

$$-x_1 + x_2 \le 2$$
$$-x_1 + 3x_2 \le 12$$
$$x_1 - 4x_2 \le 4$$
$$x_1 \ge 0, x_2 \ge 0$$

15. Solve the following LPP by Big-M, method: [8]

Maximize, $P = 2x_1+5x_2$

Subject to:

$$x_1 + 2x_2 \le 18$$
$$2x_1 + x_2 \le 21$$
$$x_1 + x_2 \ge 10$$
$$x_1 \ge 0, x_2 \ge 0$$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except BAR)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate* **Full Marks.**
- ✓ *Assume suitable data if necessary.*

1. Use the Properties of determinant to show that:
$$\begin{vmatrix} (a+b)^2 & ca & bc \\ ca & (b+c)^2 & ab \\ bc & ab & (c+a)^2 \end{vmatrix} = 2abc\,(a+b+c)^3$$ [5]

2. Define Hermitian and Skew-Hermitian of a square complex matrix. If A is any square matrix, prove that $A + A^*$ is Hermitian and $A - A^*$ is Skew – Hermitian matrix. [5]

3. Test the consistency of the system by matrix rank method and solve it completely if consistent: [5]
$x+2y-z=0,\ 2x+3y+z=10,\ 3x-y-7z=1$

4. Find the eigenvalues of the matrix $A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$ and use them to compute
(i) eigenvalues of A-1
(ii) determinant of A [2+1+1+1]
(iii) eigenvalues of adj A

5. Evaluate $\int_C \vec{F}.d\vec{r}$ where $\vec{F} = \text{Sin}y\,\vec{i} + x(1+\cos y)\vec{j}$ and C is the circular path given by $x^2 + y^2 = a^2, z = 0.$ [5]

6. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$ where $\vec{F} = yz\,\vec{i} + zx\,\vec{j} + xy\,\vec{k}$ where S is the surface of the sphere $x^2+y^2+z^2=1$ in the first octant. [5]

7. Apply Green's Theorem in plane to compute the area of the curve $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} = 1.$ [5]

8. State Gauss divergence theorem in vector calculus. Apply it to evaluate $\iint_S \left[(x^3-yz)\vec{i} - 2x^2y\vec{j} + 2\vec{k}\right].\vec{n}\,ds$ where S denote the surface of the cube bounded by the planes $x=0, x=a, y=0, y=a, z=0, z=a.$ [1+4]

9. State the condition for existence property of Laplace transform. Find the Laplace transform of: (a) $\frac{1}{\sqrt{t}}$ (b) $\frac{1-\cos 2t}{t}$ [1+2+2]

10. State the convolution theorem for inverse Laplace transform and use it to find the inverse Laplace transform of $\frac{s}{(s^2+1)(s^2+4)}$. [5]

11. Solve the initial value problem by applying Laplace transform: [5]

$$y'' - 10y' + 9y = 5t,\ y(0) = -1,\ y'(0) = 2.$$

12. Obtain the Fourier series of $f(x) = x + x^2$ in $-\pi \leq x \leq \pi$. [5]

13. Express $f(x) = x^2$ as a half-range sine series in $0 < x < 3$. [5]

14. Solve following LPP by the Simplex method: [7]

Maximize, $P = x_1 + x_2$

Subject to : $2x_1 + x_2 \leq 16$

$x_1 \leq 6$

$x_2 \leq 10$

$x_1 \geq 0,\ x_2 \geq 0$

15. Solve following LPP by the Dual Method: [8]

Minimize, $C = 21x_1 + 50x_2$

Subject to : $2x_1 + 5x_2 \geq 12$

$3x_1 + 7x_2 \geq 17$

$x_1 \geq 0,\ x_2 \geq 0$

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TRIBHUVAN UNIVERSITY INSTITUTE OF ENGINEERING **Examination Control Division** **2078 Kartik**				
	Exam.	**Back**		
	Level	BE	**Full Marks**	80
	Programme	All (Except BAR)	**Pass Marks**	32
	Year / Part	II / I	**Time**	3 hrs.

Subject: - Engineering Mathematics III *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. If $\begin{vmatrix} a & a^2 & a^3-1 \\ b & b^2 & b^3-1 \\ c & c^2 & c^3-1 \end{vmatrix} = 0$; where $a \neq b \neq c$, apply the properties of determinants to show $abc = 1$. [5]

2. Define an orthogonal matrix. Prove that the product of two orthogonal matrices of the same order is also orthogonal. [5]

3. For the matrix $= \begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$, find the modal matrix and the corresponding diagonal matrix. [5]

4. State Cayley-Hamilton theorem and verify the theorem for the square matrix $A = \begin{bmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{bmatrix}$. [5]

5. Prove that "for any simple closed curve C, the line integral $\int_A^B \vec{F}.d\vec{r}$ is independent of the path joining the points A and B in the region if and only if $\int_C \vec{F}.d\vec{r} = 0$. [5]

6. State Green's theorem in the plane. Using Green's theorem find the area of the hypocycloid $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} = 1$. [5]

7. Evaluate $\iint_S \vec{F}.\vec{n}\, ds$ by Gauss' divergence theorem, where $\vec{F} = x\,\vec{i} - y\,\vec{j} + (z^2-1)\,\vec{k}$ and S is the cylinder formed by the surfaces $x^2 + y^2 = 4$, $z = 0$, $z = 1$. [5]

8. Verify Stoke's theorem for $\vec{F} = (x^2 - y^2)\vec{i} + 2xy\vec{j}$ taken over the rectangular bounded by the lines $x = 0, x = a, y = 0, y = b$. [5]

9. Define Laplace transform of f(t). Find the Laplace transform of:

   a) $t\,e^{-t}\cosh t$ b) $\frac{\sin t \sin 5t}{t}$ [1+1.5+2.5]

10. Find the inverse Laplace transform of:

    a) $\log\frac{s}{s+1}$ b) $\frac{1}{(s-2)(s^2+1)}$ [2.5+2.5]

11. Solve the initial value problem $y'' + 4y' + 3y = 0$, $y(0) = 3$, $y'(0) = 1$ by using Laplace transform. [5]

12. Find the Fourier series of $f(x) = 2x - x^2$ in (0, 2). [5]

13. Obtain the half range sine series for $f(x) = e^x$ in $0 < x < 1$. [5]

14. Use Simplex method to solve following LPP: [7]

    Maximize, $P = 50x_1 + 80x_2$
    Subject to: $x_1 + 2x_2 \leq 32$
    $3x_1 + 4x_2 \leq 84$
    $x_1, x_2 \geq 0$

15. Solve the following LPP by using big M method: [8]

    Maximize, $P = 2x + y$

    Subject to: $x + y \leq 10$
    $-x + y \geq 2$
    $x, y \geq 0$

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except BAR)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: **- Engineering Mathematics III** *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Prove that $\begin{vmatrix} 1+a^2-b^2 & 2ab & -2b \\ 2ab & 1-a^2+b^2 & 2a \\ 2b & -2a & 1-a^2-b^2 \end{vmatrix} = (1+a^2+b^2)^3$ by using the properties of determinants. [5]

2. Prove that every square complex matrix can uniquely be expressed as a sum of a Hermitian and a skew-Hermitian matrix. [5]

3. Reduce the matrix $\begin{bmatrix} 1 & 0 & -5 & 6 \\ 3 & -2 & 1 & 2 \\ 5 & -2 & -9 & 14 \\ 4 & -2 & -4 & 8 \end{bmatrix}$ into normal form and hence find its rank. [5]

4. Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & -1 \\ 0 & 0 & 2 \end{bmatrix}$ and also fnd its modal matrix. [5]

5. If $\vec{F} = 3x^2yz^2\,\vec{i} + x^3z^2\,\vec{j} + 2x^3yz\,\vec{k}$, show that $\int_C \vec{F}.d\vec{r}$ is independent of the path of integration. Hence evaluate the integral on any path C from (0, 0, 0) to (1, 2, 3). [5]

6. Verify Green's Theorem in plane for $\int_c [(x-y)\,dx + (x+y)\,dy]$ where c is the boundary of the region enclosed by $y^2 = x$ and $x^2 = y$. [5]

7. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$ where $\vec{F} = 4x\,\vec{i} - 2y^2\,\vec{j} + z^2\,\vec{k}$ taken over the region bounded by the cylinder $x^2 + y^2 = 4$ and the planes $z = 0, z = 3$. [5]

8. Evaluate $\int_c \vec{F}.d\vec{r}$, where c is the rectangle bounded by the lines $x = \pm a$, $y = 0$, $y = n$ and $\vec{F} = (x^2+y^2)\,\vec{i} - 2xy\,\vec{j}$. [5]

9. State the condition for existence of Laplace transform. Obtain the Laplace transform of:

   a) $\cos^3 2t$ (b) $\dfrac{\cos at - \cos bt}{t}$ [1+1.5+2.5]

10. Find the inverse Laplace transform of:

a) $\dfrac{s+3}{(s^2+6s+13)^2}$ b) $\dfrac{e^{-2s}}{(s+1)(s^2+2s+2)}$ [2+3]

11. Solve the differential equation $y''+2y'-3y=\sin t$ under the conditions $y(0)=y'(0)=0$ by using Laplace transform. [5]

12. Obtain the Fourier series to represent the function $f(x)=e^x$ for $-\pi \le x \le \pi$. [5]

13. Obtain the half range cosine series for the function $f(x)=x\sin x$ in the interval $(0, \pi)$. [5]

14. Use Simplex method to solve following LPP:

Maximize, $P = 30x_1 + x_2$

Subject to : $2x_1 + x_2 \le 10$
$x_1 + 3x_2 \le 10$
$x_1, x_2 \ge 0$ [7]

15. Use Big M method to solve following LPP:

16. Minimize, $Z = 4x_1 + 2x_2$

Subject to : $3x_1 + x_2 \ge 27$
$-x_1 - x_2 \le -21$
$x_1 + 2x_2 \ge 30$
$x_1, x_2 \ge 0$ [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	All except BAR	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Prove that: $\begin{vmatrix} (b+c)^2 & c^2 & b^2 \\ c^2 & (c+a)^2 & a^2 \\ b^2 & a^2 & (a+b)^2 \end{vmatrix} = 2(ab+bc+ca)^2$ [5]

2. Prove that the necessary and sufficient condition for a square matrix A to possess an inverse is that $|A| \neq 0$. [5]

3. Find the rank of the matrix $\begin{bmatrix} 2 & -2 & 0 & 6 \\ 4 & 2 & 0 & 2 \\ 1 & -1 & 0 & 3 \\ 1 & -2 & 1 & 2 \end{bmatrix}$ by reducing it to normal form. [5]

4. State any two properties of eigen values of a matrix. Obtain eigen values and eigen vectors of the matrix $\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$ [1+4]

5. Prove that the line integral $\int_A^B \vec{F}.d\vec{r}$ is independent of path joining any two points A and B in the region if and only if $\int_C \vec{F}.d\vec{r} = 0$ for any simple closed curve C in the region. [5]

6. State Green's Theorem and use it to find the area of the curve $\left(\frac{x}{a}\right)^{2/3} + \left(\frac{y}{b}\right)^{2/3} = 1$. [1+4]

7. Use Gauss' divergence theorem to evaluate $\iint_S \vec{F}.\vec{n}ds$ where $\vec{F} = (2xy+z)\vec{i} + y^2\vec{j} - (x+3y)\vec{k}$ and S is the surface bounded by the plane 2x+3y+z=6, x=0, y=0, z=0. [5]

8. Verify Stoke's Theorem for the vector field $\vec{F} = (2x-y)\vec{i} - yz^2\vec{j} - y^2z\vec{k}$ over the upper half of the sphere $x^2+y^2+z^2=1$ bounded by its projection on xy-plane. [5]

9. Find the Laplace transform of: [2+3]
   i) $t^2 \cos at$
   ii) $\frac{1-\cosh(at)}{t}$

10. Find the inverse Laplace transform of : [2+3]

i) $\dfrac{e^{-\pi s}(s+1)}{s^2+2s+2}$

ii) $\tan^{-1}\dfrac{2}{s}$

11. Solve the differential equation $y''+3y'+2y=e^{-t}$, $y(0)=y'(0)=0$ by applying Laplace transform. [5]

12. Find the Fourier Series of the function $f(x)=|\sin x|$ for $-\pi \le x \le \pi$. [5]

13. If $f(x) = lx-x^2$ in $(0,l)$, show that the half range sine series for $f(x)$ is $\dfrac{8l^2}{\pi^3}\sum_{n=0}^{\infty}\dfrac{1}{(2n+1)^3}\sin(2n+1)\dfrac{\pi x}{l}$. [5]

14. Find the maximum and minimum values of the function $z=20x+10y$ subject to: $x+2y\le 40$, $3x+y\ge 30$, $4x+3y \ge 60$, $x,y\ge 0$ by graphical method. [5]

15. Solve the following linear programming problem using big M method:

Maximize $P=2x_1+5x_2$

subject to : $x_1+2x_2 \le 18$

$2x_1+x_2 \ge 21$

$x_1, x_2 \ge 0$. [10]

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02 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: **- Engineering Mathematics III** ***(SH501)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define the determinant as a function and using its properties. Show that [5]

$$\begin{vmatrix} b+c & c+a & a+b \\ q+r & r+p & p+q \\ y+z & z+x & x+y \end{vmatrix} = 2\begin{vmatrix} a & p & x \\ b & q & y \\ c & r & z \end{vmatrix}$$

2. If A and B are orthogonal matrices of same order, prove that the product AB is also orthogonal. [5]

3. Test the consistency of the system $x-2y+2z=4$, $3x+y+4z=6$ and $x+y+z=1$ and solve completely if found consistent. [5]

4. For a matrix $A=\begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$, find the modal matrix and the corresponding diagonal matrix. [5]

5. Prove that line integral $\int_A^B \vec{F}.d\vec{r}$ is independent of path joining any two points A and B in the region if and only if $\int_C \vec{F}.d\vec{r}=0$ for any simple closed curve C in the region. [5]

6. Verify Green's theorem in the plane for $\int_C [(3x^2-8y^2)dx+(4y-6xy)dy]$ where C is region bounded by $y=x^2$ and $x=y^2$. [5]

7. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$ where $\vec{F}=6z\vec{i}-4\vec{j}+y\vec{k}$ and S is the region of the plane $2x+3y+6z=12$ bounded in the first octant. [5]

8. Evaluate using Gauss divergence theorem, $\iint_S \vec{F}.\vec{n}\,ds$ where $\vec{F}=x^2y\vec{i}+xy^2\vec{j}+2xyz\vec{k}$ and S is the surface bounded by the planes $x=0, y=0, z=0, x+2y+z=2$. [5]

9. Obtain the Fourier Series to represent $f(x)=x-x^2$ from $x=-\pi$ to $x=\pi$ and deduce that [5]

$$\frac{\pi^2}{12}=\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\text{.........}$$

10. Obtain the half range Fourier Sine Series for $f(x)=\pi - x$ in the range $0<x<\pi$. [5]

11. State the conditions for existence of Laplace transform. Obtain the Laplace transform of: [1+2+2]

(i) $e^{2t}\cos^3 2t$ (ii) $\dfrac{\cos 2t-\cos 3t}{t}$

12. Find the inverse Laplace transform of:

(i) $\frac{1}{(S-2)(S^2+1)}$ (ii) $\cot^{-1}(S+1)$ [2.5+2.5]

13. Solve the following intial value problem by using Laplace transform:

$y'' + 4y' + 3y = e^t$, $y(0) = 0; y'(0) = 2$ [5]

14. Graphically maximize $Z = 7x_1 + 10x_2$

Subject to constraints:

$$3x_1 + x_2 \le 9$$
$$x_1 + 2x_2 \le 8$$
$$x_1, x_2 \ge 0.$$

[5]

15. Solve the following linear Programming Problem by simple method:

Maximize: $Z = 3x_1 + 5x_2$

Subject to:

$$3x_1 + 2x_2 \le 18$$
$$x_1 \le 4,\ x_2 \le 6$$
$$x_1, x_2 \ge 0.$$

[10]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	All except BAR	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Math III *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. If $\begin{vmatrix} a & a^2 & a^3-1 \\ b & b^2 & b^3-1 \\ c & c^2 & c^3-1 \end{vmatrix} = 0$, where $a \neq b \neq c$ show that $abc=1$. [5]

2. If A is a square matrix of order n, prove that $A(\text{adj. } A) = (\text{adj. } A)A = |A|I_n$, where I_n is a unit matrix having same order as A. [5]

3. Test the consistency of the system by matrix rank method and solve completely if found consistent: $x+2y-z=3$, $2x+3y+z=10$, $3x-y-7z=1$ [5]

4. State Cayley-Hemilton Thorem and verify it for the matrix $A=\begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$ [1+4]

5. A vector field is given by $\vec{F} = \sin y\,\vec{i} + x(1+\cos y)\vec{j}$. Evaluate the line integral $\int_c \vec{F}.d\vec{r}$ over the circular path c given by $x^2+y^2=a^2$, $z=0$. [5]

6. State and prove Green's Theorem in plane. [1+4]

7. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$ for $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$ where S is the surface of the sphere $x^2+y^2+z^2=1$ in the first octant. [5]

8. State Stoke's theorem. Evaluate $\oint_c (xydx + xy^2dy)$ by Stoke's theorem taking c to be a square in the xy-plane with vertices (1,0),(-1,0),(0,1) and (0,-1). [1+4]

9. Find the Laplace transform of: [2+3]
   i) $te^{-t}\sin t$
   ii) $\dfrac{\cos 2t - \cos 3t}{t}$

10. Find the inverse Laplace transform of: [2+3]
    i) $\dfrac{s+2}{(s+1)^4}$
    ii) $\cot^{-1}(s+1)$

11. Solve the differential equation $y''+y=\sin 3t$, $y(0)=y'(0)=0$ by using Laplace transform. [5]

12. Define Fourier Series for a function f(x). Obtain Fourier series for $f(x)=x^3$; $-\pi \le x \le \pi$. [5]

13. Express $f(x)=e^x$ as the half range Fourier Sine series in $0<x<1$. [5]

14. Find the maximum and minimum values of the function $z = 50x_1 + 80x_2$ subject to: $x_1 + 2x_2 \le 32$, $3x_1 + 4x_2 \le 84$, $x_1x_2 \ge 0$; by graphical method. [5]

15. Solve the following Linear Programming problem using big M method: [10]
    Maximize $P= 2x_1+x_2$
    Subject to: $x_1+x_2 \le 10$
    $-x_1+x_2 \ge 2$
    $x_1, x_2 \ge 0$

01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. If $\begin{vmatrix} a & a^2 & a^3-1 \\ b & b^2 & b^3-1 \\ c & c^2 & c^3-1 \end{vmatrix} = 0$ where $a \neq b \neq c$; apply properties of determinant to show $abc = 1$. [5]

2. If A be an $n \times n$ matrix, prove that

   $\text{Adj}(A) . A = A . (\text{Adj}A) = |A| I$ where I is an $n \times n$ unit matrix. [5]

3. Find the rank of the following matrix by reducing it into normal form:

   $$\begin{pmatrix} 3 & 1 & 4 \\ 0 & 5 & 8 \\ -3 & 4 & 4 \\ 1 & 2 & 4 \end{pmatrix}$$ [5]

4. Find the modal matrix for the matrix

   $$A = \begin{pmatrix} 2 & 1 & 1 \\ -2 & 1 & 3 \\ 2 & 1 & -1 \end{pmatrix}$$ [5]

5. State and prove Green's theorem in plane. [5]

6. Find the total work done in moving the particle in a force field given by $\vec{F} = \text{Sin}y\,\vec{i} + x(1+\cos y)\,\vec{j}$ over the circular path $x^2 + y^2 = a^2$, $z = 0$. [5]

7. Evaluate $\iint_s \vec{F}.d\vec{s}$ where $\vec{F} = x\,\vec{i} - y\,\vec{j} + z\,\vec{k}$ and s is the surface of the cylinder $x^2 + y^2 = a^2, 0 < z < b$. [5]

8. Verify Stoke's theorem for $\vec{F} = (x^2 + y^2)\,\vec{i} - 2xy\,\vec{j}$ taken round the rectangle bounded by the lines $x = \pm a, y = 0, y = b$. [5]

9. Obtain Fourier series for $f(x) = x^3$ in the interval $-\pi \leq x \leq \pi$. [5]

10. Express $f(x) = e^x$ as a half range Fourier Cosine Series in $0 < x < 1$. [5]

11. State existence theorem for Laplace Transform. Obtain the Laplace transform of

    a) $te^{-t} \sin t$ b) $\dfrac{e^{-at} - e^{-bt}}{t}$ 1+2+2]

12. Find the inverse Laplace transform of:

a) $\dfrac{1}{s^2-5s+6}$ b) $\tan^{-1}\dfrac{2}{s}$ [2+5.+2.5]

13. By using Laplace transform, solve the initial value problem:

$y'' + 2y = r(t)$, $y(0) = y'(0) = 0$

Where $r(t) = 1, 0 < t < 1$

$= 0$, otherwise [5]

14. Graphically maximize $Z = 5x_1 + 3x_2$ Subject to constraints

$x_1 + 2x_2 \le 50$

$2x_1 + x_2 \le 40.$ [5]

$x_1, x_2 \ge 0$

15. Solve the following Linear Programming Problem by simple method:

Maximize : $Z = 4x + 3y$

Subject to : $2x + 3y \le 6$

$-x + 2y \le 3$

$2y \le 5$

$2x + y \le 4$

$x, y \ge 0.$ [10]

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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	ALL (Except B. Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Use properties of determinant to show [5]

$$\begin{vmatrix} x^2 & x^2-(y-z)^2 & yz \\ y^2 & y^2-(z-x)^2 & zx \\ z^2 & z^2-(x-y)^2 & xy \end{vmatrix} = (x-y)(y-z)(z-x)(x+y+z)(x^2+y^2+z^2)$$

2. Prove that every square matrix can be uniquely expressed as the sum of symmetric and a skew symmetric matrix. [5]

3. Define eigen values and eigen vectors in terms of linear transformation with matrices as operator. Find eigen values of the matrix. [2+3]

$$\begin{pmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{pmatrix}$$

4. Test the consistency of the system $x+y+z=3$, $x+2y+3z=4$, $2x+3y+4z=7$ by using rank of matrix method and solve if consistent. [5]

5. If $\vec{F}$ is the gradient of some scalar point functions ϕ i.e $\vec{F}=\nabla\phi$, prove that the line integral is independent of the path joining any two points in the region and conversely. [5]

6. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$, where $\vec{F}=xy\,\vec{i}-x^2\,\vec{j}+(x+z)\vec{K}$ and S is the region of the plane $2x+2y+z=6$ bounded in the first quadrant. [5]

7. State and prove Green's theorem in plane. [5]

8. Apply Gauss' divergence theorem to evaluate $\iint_S \left[\left(x^3-yz\right)\vec{i}-2x^2y\,\vec{j}+2\vec{K}\right].\vec{n}\,ds$, where S is the surface of the cube bounded by the planes x = 0, x = a, y = 0, y = a, z = 0, z = a. [5]

9. Expand f(x) = x sinx as a Fourier series in $-\pi \le x \le \pi$. [5]

10. Obtain half range cosine series for f(x) = x in the interval $0 \le x \le \pi$. [5]

11. Find the Laplace transform of: [3+2]

    i) $t^2 \cos at$

    ii) $\frac{\sin t}{t}$

12. State convolution theorem for inverse Laplace transform and use it to find the inverse Laplace transform of $\frac{S}{(S^2+4)(S^2+9)}$ [1+4]

13. Solve the following initial value problem by using Laplace transform: [5]

$y''+2y'-3y=\sin t,\ y(0)=y'(0)=0$

14. Graphically maximize [5]

$Z=7x_1+10x_2$

Subject to constraints,

$3x_1+x_2\le 9$

$x_1+2x_2\le 8$

$x_1,x_2\ge 0$

15. Solve the following LPP by simplex method using duality of: [10]

Minimize Z = 20x+50y

Subject to:

$2x+5y\ge 12$

$3x+7y\ge 17$

$x,y\ge 0$

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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B. Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Distinguish a matrix and a determinant. Use property of determinant to prove: [5]

$$\begin{vmatrix} a+b+2c & a & b \\ c & b+c+2a & b \\ c & a & c+a+2b \end{vmatrix} = 2(a+b+c)^3$$

2. Prove that the necessary and sufficient condition for a square matrix to posses an inverse is that it is non singular. [5]

3. Find the rank of the matrix: [5]

$$\begin{pmatrix} 1 & 0 & -5 & 6 \\ 3 & -2 & 1 & 2 \\ 3 & -2 & -9 & 14 \\ 4 & -2 & -4 & 8 \end{pmatrix}$$ by reducing it to normal form.

4. State Cayley-Hamilton theorem and use it to find inverse of the matrix $\begin{pmatrix} 4 & 3 & 1 \\ 2 & 1 & -2 \\ 1 & 2 & 1 \end{pmatrix}$ [5]

5. Find the work done by the force $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$ in displacement of a particle along the straight segment C from point (1,1,1) to the point (3,3,2). [5]

6. State Gauss divergence theorem and apply it to evaluate $\iint_S \vec{F}.\vec{n}\,ds$, where $\vec{F} = x\vec{i} + y\vec{j} + z\vec{k}$ and S is the surface of the cube bounded by the planes x = 0, x = a, y = 0, y = a, z = 0, z = a. [5]

7. State and prove Green's theorem in plane. [5]

8. Verify stokes theorem for the vector field $\vec{F} = (2x-y)\vec{i} - yz^2\vec{j} - y^2z\vec{k}$ over the upper half of the surface of $x^2+y^2+z^2=1$ bounded by its projection the xy-plane. [5]

9. Find the Fourier series to represent $f(x) = x - x^2$ from $-\pi$ to π. [5]

10. Find the half range Fourier sine series for $f(x) = e^{2x}$ in $0 < x < \pi$. [5]

11. Define Laplace transform of a function and state criteria of existence of a Laplace transform of a function. Find the Laplace transform of $f(t) = \dfrac{1-\cos 2t}{t}$ [1+1+3]

12. Find inverse Laplace transform of [2+3]

(i) $\frac{1}{s(s+2)}$ (ii) $\tan^{-1}\left(\frac{1}{s}\right)$

13. Solve the following initial value problem using Laplace transform: [5]

$y''+4y'+3y=0, \quad y(0)=3, \quad y'(0)=1$

14. Use simplex method to solve the following LPP: [10]

Maximum $z=50x_1+80x_2$

Subject to,

$$x_1+2x_2 \le 32$$
$$3x_1+4x_2 \le 84$$

15. Graphically maximize [5]

$z=7x_1+10x_2$

Subject to,

$$3x_1+x_2 \le 9$$
$$x_1+2x_2 \le 8$$
$$x_1, x_2 \ge 0$$

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B. Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Use properties of determinants to prove: [5]

$$\begin{vmatrix} a^2+1 & ba & ca & da \\ ab & b^2+1 & cb & db \\ ac & bc & c^2+1 & dc \\ ad & bd & cd & d^2+1 \end{vmatrix} = 1+a^2+b^2+c^2+d^2$$

2. Show that every square matrix can be uniquely expressed as the sum of symmetric and Skew-Symmetric matrices. [5]

3. Test the consistency of the system $x+y+z=3, x+2y+3z=4$ and $2x+3y+4z=7$ and solve completely if found consistent. [5]

4. State Cayley-Hamilton theorem and verify it for the matrix; $A = \begin{pmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{pmatrix}$ [1+4]

5. Prove that " The line integral $\int_c \vec{F}.d\vec{r}$ of a continuous function $\vec{F}$ defined in a region R is independent of path C joining any two points in R if and only if there exists a single valued scalar function ϕ having first order partial derivatives such that $\vec{F} = \nabla\phi$". [5]

6. State Green's theorem and use it to find the area of astroid $x^{2/3}+y^{2/3}=a^{2/3}$ [5]

7. Evaluate $\iint_s \vec{F}.\vec{n}\, ds$, where $\vec{F} = x^2\vec{i}+y^2\vec{j}+z^2\vec{k}$ and 's' is the surface of the plane $x+y+z=1$ between the co-ordinate planes. [5]

8. Apply Gauss' divergence theorem to evaluate $\iint_s \vec{F}.\vec{n}\, ds$ where

$\vec{F} = (x^3 - yz)\vec{i} - 2x^2y\,\vec{j} + 2\vec{k}$ and 's' is the surface the cube bounded by the planes $x=0, x=a, y=0, y=a, z=0, z=a$. [5]

9. Find the Laplace transform of: [2+3]

i) $t\sin^2 3t$

ii) $\dfrac{\sin 2t}{t}$

10. Find the inverse Laplace transform of: [2+3]

i) $\dfrac{1}{s^2-3s+2}$

ii) $\dfrac{1}{s(s+1)^3}$

11. Apply Laplace transform to solve the differential equation: [5]

$y''+2y'+5y=e^{-t}\sin t,\quad x(0)=0, x'(0)=1$

12. Find a Fourier series to represent $f(x)=x-x^2$ from $x=-\pi$ to $x=\pi$. Hence show that

$$\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\ldots\ldots=\frac{\pi^2}{12}$$ [5]

13. Develop $f(x)=\sin\left(\frac{\pi x}{l}\right)$ in half range Cosine Series in the range $0<x<l$. [5]

14. Graphically maximize, [5]

$Z=7x_1+10x_2$

Subject to constraints,

$3x_1+x_2\le 9$

$x_1+2x_2\le 8$

$x_1\ge 0, x_2\ge 0$

15. Solve the following LPP using simplex method. [10]

Maximize: $P=50x_1+80x_2$

Subject to: $x_1+2x_2\le 32$

$3x_1+4x_2\le 84$

$x_1\ge 0, x_2\ge 0$

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	**Full Marks**	80
Programme	All (Except B.Arch)	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Prove that $\begin{vmatrix} (a+b)^2 & ca & bc \\ ca & (b+c)^2 & ab \\ bc & ab & (c+a)^2 \end{vmatrix} = 2abc(a+b+c)^3$ [5]

2. If A and B are two non singular matrices, then prove that $(AB)^{-1} = B^{-1}A^{-1}$ [5]

3. Find the rank of the matrix: [5]

$$\begin{pmatrix} 1 & -1 & -2 & -4 \\ 2 & 3 & -1 & -1 \\ 3 & 1 & 3 & -2 \\ 6 & 3 & 0 & -7 \end{pmatrix}$$

4. Find the eigen values and eigen vectors of the matrix. [5]

$$\begin{pmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{pmatrix}$$

5. Prove that the line integral $\int_A^B \vec{F}.d\vec{r}$ is independent of path joining any two points A and B in the region R, if and only if, $\int_C \vec{F}.d\vec{r} = 0$ for any simple closed path C in R. [5]

6. Evaluate $\iint_S \vec{F}.\vec{n}\,ds$ where $\vec{F} = yz\,\vec{i} + zx\,\vec{j} + xy\,\vec{k}$ where S is the surface of the sphere $x^2 + y^2 + z^2 = 1$ in the first octant. [5]

OR

Apply Stoke's theorem to evaluate $\int_C (x+y)dx + (2x-z)dy + (y+z)\,dz$ where C is the boundary of the triangle with vertices (2,0,0), (0,3,0) and (0,0,6). [5]

7. State Green's theorem in plane and hence apply it to compute the area of the curve $x^{2/3} + y^{2/3} = a^{2/3}$. [5]

8. Apply Gauss divergence theorem to evaluate $\iint_S \vec{F}.\vec{n}\, ds$ where $\vec{F} = x^2\vec{i} + z\vec{j} + yz\vec{k}$ taken over the cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$. [5]

9. Find the Laplace transform of the following: [2.5×2]

   a) $\dfrac{\cos 2t - \cos 3t}{t}$

   b) $\sin^3 2t$

10. Find the inverse Laplace transform of the following: [2+3]

    a) $\dfrac{1}{s^2 - 5s + 6}$

    b) $\dfrac{s+2}{(s^2+4s+5)^2}$

11. Solve the initial value problem by using Laplace transform: [5]

    $x''+2x'+5x = e^{-t}\sin t;\ x(0) = 0,\ x'(0) = 1$

12. Obtain Fourier Series for the function $f(x) = x - x^2$ from $-\pi$ to π and hence show that: [5]

    $\dfrac{\pi^2}{12} = \dfrac{1}{1^2} - \dfrac{1}{2^2} + \dfrac{1}{3^2} - \dfrac{1}{4^2} + \ldots\ldots\ldots$

13. Obtain the half range sine series for the function $f(x) = x^2$ in the interval (0,3). [5]

14. Graphically maximize and minimize [5]

    $Z = 5x_1 + 3x_2$ Subjected to constraints

    $3x_1 + 5x_2 \le 15$
    $5x_1 + 2x_2 \le 10, x_1, x_2 \ge 0$

15. Use simplex method to solve the Linear Programming problem: [10]

    Maximize $Z = 15x_1 + 10x_2$

    Subject to $2x_1 + 2x_2 \le 10$
    $x_1 + 3x_2 \le 10$

    and $x_1, x_2 \ge 0$

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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. Using the properties, evaluate the determinant: [5]

$$\begin{vmatrix} 1 & a & a^2 & a^3+bcd \\ 1 & b & b^2 & b^3+cda \\ 1 & c & c^2 & c^3+abd \\ 1 & d & d^2 & d^3+abc \end{vmatrix}$$

2. Prove that every square matrix can uniquely be expressed as the sum of a symmetric and a skew symmetric matrix. [5]

3. Test the consistency of the system: [5]

$x-6y-z=10,\ 2x-2y+3z=10,\ 3x-8y+2z=20$

And solve completely, if found consistent.

4. Find the eigen values and eigenvecters of the matrix $\begin{pmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{pmatrix}$. [5]

5. Using the line integral, compute the workdone by the force [5]

$\vec{F}=(2x-y+2z)\vec{i}+(x+y-z)\vec{j}+(3x-2y-5z)\vec{k}$

when it moves once around a circle $x^2+y^2=4; z=0$

6. State and prove Green's Theorem in plane. [5]

7. Verify Stoke's theorem for $\vec{F}=(x^2+y^2)\vec{i}-2xy\vec{j}$ taken around the rectangle bounded by the lines $x=\pm a$, $y=0$, $y=b$. [5]

8. Evaluate $\iint_S \vec{F}.\vec{n}\ ds$ where $\vec{F}=(2xy+z)\vec{i}+y^2\vec{j}-(x+3y)\vec{K}$ by Gauss divergence theorem; where S is surface of the plane $2x+2y+z=6$ in the first octant bounding the volume V. [5]

9. Find the Laplace transform of the following: [2.5×2]

a) $te^{-2t}\cos t$

b) Sinhat.cos t

10. Find the inverse Laplace transform of : [2.5×2]

a) $\dfrac{1}{S(S+1)}$

b) $\dfrac{S^2}{(S^2+b^2)^2}$

11. Solve the differential equation $y''+2y'+5y = e^{-t}\sin t, y(0)=0, y'(0)=1$, by using Laplace transform. [5]

12. Expand the function $f(x) = x \sin x$ as a Fourier series in the interval $-\pi \le x \le \pi$. [5]

13. Obtain half range sine series for the function $f(x) = x - x^2$ for $0 < x < 1$. [5]

14. Graphically maximize and minimize [5]

$z = 9x + 40y$ subjected to the constraints

$y - x \ge 1, y - x \le 3, 2 \le x \le 5$

15. Solve the following Linear Programming Problem by Simplex method: [10]

Maximize, $P = 20x_2 - 5x_1$

Subjected to, $10x_2 - 2x_1 \le 5$

$2x_1 + 5x_2 \le 10$ and $x_1, x_2 \ge 0$

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	All (Except B.Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Show that: $\begin{vmatrix} (b+c)^2 & b^2 & c^2 \\ a^2 & (c+a)^2 & c^2 \\ a^2 & b^2 & (a+b)^2 \end{vmatrix} = 2abc(a+b+c)^3$ [5]

2. Prove that every square matrix can be uniquely written as a sum of Hermitian and Skew-Hermitian matrices. [5]

3. Find the rank of the matrix by changing it into normal form: $\begin{pmatrix} 3 & 1 & 4 \\ 0 & 5 & 8 \\ -3 & 4 & 4 \\ 1 & 2 & 4 \end{pmatrix}$ [5]

4. Find the eigen value and eigen vector of the matrix: $\begin{pmatrix} 2 & 1 & 1 \\ -2 & 1 & 3 \\ 2 & 1 & -1 \end{pmatrix}$ [5]

5. Using Green's theorem, evaluate $\int_C (y^3dx - x^3dy)$ where C is the boundary of the circle $x^2 + y^2 = 4$. [5]

6. Show that $\vec{F}(x,y,z) = y^3\,\vec{i} + (3xy^2 + e^{2z})\,\vec{j} + 2ye^{2z}\,\vec{k}$ is conservative vector field and find its scalar potential function. [5]

7. Find the surface integral $\iint_S \vec{F}.\hat{n}\,ds$ where $\vec{F} = x\,\vec{i} + y\,\vec{j} + z\,\vec{k}$ and S is the upper half of the sphere $x^2 + y^2 + z^2 = 1$. [5]

8. Verify Stoke's theorem for $\vec{F}(x,y,z) = (2x - y)\,\vec{i} - yz^2\,\vec{j} - y^2z\,\vec{k}$ where S is the upper half of the sphere $x^2 + y^2 + z^2 = 4$ and C is its boundary. [5]

OR

Evaluate using Gauss divergence theorem,
$\iint_S \vec{F}.\hat{n}\,ds$ where $\vec{F}(x,y,z) = x^2y\,\vec{i} + xy^2\,\vec{j} + 2xyz\,\vec{k}$ and S is the surface bounded by the planes x = 0, y = 0, z =0 and x+2y+z =2

9. Find the Laplace transform of (i) sin 2t cosh 4t (ii) $te^{2t}\sin 4t$. [5]

10. Using the Convolution theorem, find the inverse Laplace transform of $\frac{3s}{(s^2+4)(s^2+1)}$ [5]

11. Solve the following initial value problem using Laplace transform: [5]

$$y''+4y'+3y = e^t, y(0) = 00, y'(0) = 2$$

12. Obtain the half range Fourier sine series of $f(x) = \pi - x$ in the range $0 < x < \pi$. [5]

13. Obtain the Fourier series of $f(x) = e^{3x}$ in $0 < x < 2\pi$. [5]

14. Graphically maximum $Z = 5x_1 + 3x_2$ subject to constraints [5]

$$x_1 + 2x_2 \leq 50, 2x_1 + x_2 \leq 40 \text{ and } x_1 \geq 0, x_2 \geq 0$$

15. Solve the following linear programming problem by simplex method constructing the duality: [10]

Minimize: $P = 21x_1+50x_2$

Subject to $3x_1+7x_2 \geq 17$

$2x_1+5x_2 \geq 12$

$x_1, x_2 \geq 0$

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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B.Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Using the properties of determinant prove [5]

$$\begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix} = 2abc(a+b+c)^3$$

2. Prove that $(AB)^T = B^T A^T$ where A is the matrix of size m×p and B is the matrix of size p×n [5]

3. Find the rank of the following matrix by reducing normal form. $\begin{bmatrix} 1 & 3 & -2 & 1 \\ 1 & 1 & 1 & 1 \\ 2 & 0 & -3 & 2 \\ 3 & 3 & -3 & 3 \end{bmatrix}$ [5]

4. Find the eigen values and eigen vectors of the following matrix. $\begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & -1 \\ 0 & 0 & 2 \end{bmatrix}$. [5]

5. Prove that the line intergral $\int_A^B \vec{F}.d\vec{r}$ is independent of the path joining any two points A and B in a region if $\int_C \vec{F}.d\vec{r} = 0$ for any simple closed curve C in the region. [5]

6. Evaluate $\iint_S \vec{F}.\hat{n}\, ds$ where $\vec{F} = x^2\vec{i} + y^2\vec{j} + z^2\vec{k}$ and S is the finite plane x + y + z = 1 between the coordinate planes. [5]

OR

Evaluate $\iint_S \vec{F}.\hat{n}\, ds$ for $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$ where S is the surface of sphere $x^2 + y^2 + z^2 = 1$ in the first octant.

7. Evaluate, $\iint_S \vec{F}.\hat{n}\, ds$ for $\vec{F} = x\vec{i} - y\vec{j} + (z^2 - 1)\vec{k}$ where S is the surface bounded by the cylinder $x^2 + y^2 = 4$ and the planes z = 0 and z = 1 [5]

8. Verify the stoke's theorem for $\vec{F} = (2x-y)\vec{i} - yz^2\vec{j} - y^2z\vec{k}$ where S is the upper part of the sphere $x^2+y^2+z^2=a^2$ C is its boundary. [5]

9. Find the Laplace transform of (a) $t^2 \sin zt$ and (b) $\frac{1-e^t}{t}$ [2.5×2]

10. Find the inverse Laplace transform of (a) $\frac{2s+3}{s^2+5s-6}$ (b) $\frac{s^3}{s^4-a^4}$ [2.5×2]

11. Solve the following differential equation by using Laplace transform [5]
$y'' + y' - 2y = x,\ y(0) = 1,\ y'(0) = 0$

12. Obtain the Fourior series for $f(x) = x^2$ in the interval $-\pi < x < \pi$ and hence prove that [5]

$$\sum \frac{1}{x^2} = \frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} \ldots\ldots = \frac{\pi^2}{6}$$ [5]

13. Obtain half range sine series for $f(x) = \pi x - x^2$ in $(0, \pi)$ [5]

14. Graphically minimize $z = 4x_1 + 3x_2 + x_3$

Subject to $x_1 + 2x_2 + 4x_3 \geq 12$

$3x_1 + 2x_2 + x_3 \geq 8$ and $x_1, x_2, x_3 \geq 0$ [10]

15. Minimize $z = 8x_1 + 9x_2$

Subject to $x_1 + 3x_2 \geq 4$

$2x_1 + x_2 \geq 5$ with $x_1, x_2 \geq 0$

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P.3

04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Old Back (2065 & Earlier Batch)		
Level	BE	Full Marks	80
Programme	All (Except B. Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Mathematics III *(EG501SH)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *All questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. Using the properties of the determinant prove that: $\begin{vmatrix} x & a & a & a \\ a & x & a & a \\ a & a & x & a \\ a & a & a & x \end{vmatrix} = (x+3a)(x-a)^3$.

2. If A and B are square matrices of same order n, then show that B^TAB is symmetric or skew-symmetric according as A is symmetric or skew-symmetric.

3. Solve the following system of equation by Gauss elimination method:
$$2x+3y+4z=20$$
$$3x+4y+5z=26$$
$$3x+5y+6z=31$$

4. State prove Cayley - Hamilton theorem.

5. Find the Laplace transforms of the following functions: (i) $\frac{\sin^2 2t}{t}$ (ii) tsin2tcos3t.

6. Find the inverse Laplace transforms of the following functions:
(i) $\frac{4s+15}{s^2-25}$ (ii) $\frac{1}{s^2-5s+6}$

7. Prove the second shifting theorem. If $L[f(t)] = F(s)$, then $L[f(t-a)\, u(t-a)] = e^{-as}F(s)$.

8. Solve the following differential equation using Laplace transform:
$\frac{d^2y}{dt^2} + y = \sin 3t; y(0) = 0, y'(0) = 0.$

9. Find the velocity and acceleration of a particle which moves along the curve $x = 2\sin 3t$, $y = 2\cos 3t$, $z = 8t$ at any time $t=\pi/3$. And hence find their magnitudes.

10. If $\vec{V} = \text{grad}\,(x^3+y^3+z^3-3xyz)$, find div $\vec{V}$ and curl $\vec{V}$.

11. Evaluate $\int_c \vec{F}\, d\vec{r}$ if $\vec{F} = x^2\hat{i} + y^3\hat{j}$ and C is the arc of the parabola $y = x^2$ in the xy-plane from (0,0) to (1,1).

12. Verify Green's theorem in the plane for $\int_C (xy+y^2)dx + x^2dy$ where C is the closed curve of the region bounded by the straight line $y = x$ and parabola $y = x^2$.

13. Evaluate $\iint_S \vec{F}.\vec{n}\, ds$ where $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ and S is the surface of the sphere $x^2+y^2+z^2=1$ in the first octant.

14. Evaluate $\iiint_V (\nabla.\ \vec{F})dv$ where $\vec{F} = x\hat{i} - y\hat{j} + (z^2-1)\hat{k}$ for the square region in the xy plane bounded by the lines $x = 0$, $y = 0$, $x = a$ and $y = a$.

OR

Verify Stokes theorem for $\vec{F} = (2x-y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$ where S is the upper part of the sphere $x^2+y^2+z^2=a^2$ and C is its boundary.

15. Obtain the Fourier series to represent $f(x) = \dfrac{\pi - x}{2}$ in the interval $0 \le x \le 2\pi$.

16. Obtain the half range sine series for the function $f(x) = x^2$ in the interval $0 \le x \le \pi$.

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62

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division.

2069 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	All (Except B. Arch.)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH 501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Find the value of the determinant: [5]

$$\begin{vmatrix} 1 & a & a^2 & a^3+bcd \\ 1 & b & b^2 & b^3+cda \\ 1 & c & c^2 & c^3+dab \\ 1 & d & d^2 & d^3+abc \end{vmatrix}$$

2. Prove that every square matrix can be uniquely expressed as the sum of a symmetric and a skew-symmetric matrices. [5]

3. Find the rank of matrix: $\begin{bmatrix} 1 & 3 & -2 & 1 \\ 1 & 1 & 1 & 1 \\ 2 & 0 & -3 & 2 \\ 3 & 3 & -3 & 3 \end{bmatrix}$ reducing to echelon form. [5]

4. Verify Cayley-Hamiltan theorem for the matrix: $\begin{bmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{bmatrix}$ [5]

5. Find the Laplace transforms of: (a) $te^{-t}\sin t$ (b) $\dfrac{e^{at}-\cos 6t}{t}$ [5]

6. If $L[f(t)]=F(s)$, then prove that $L[f^1(t)]=SF(s)-f(o)$. [5]

7. Use Laplace transform to solve: $x''+2x'+5x=e^{-t}\sin t$ given $x(0)=0$; $x'(0)=1$. [5]

8. Obtain the Fourier series for $f(x)=x^3$ in the interval $-\pi\leq x\leq\pi$. [5]

9. Obtain half-range sine series for e^x in (0, 1). [5]

10. Maximize $z=2x_1+3x_2$ subject to constraints $x_1-x_2\leq 2$, $x_1+x_2\geq 4$ and $x_1, x_2\geq 0$ graphically. [5]

11. Solve the linear programming problems by simplex method constructing the duality [10]

Minimize $Z = 3x_1+2x_2$

Subject to $2x_1+4x_2\geq 10$

$4x_1+2x_2\geq 10$

$x_2\geq 4$ and $x_1, x_2\geq 0$

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12. Prove that $\vec{F}=(2xz^3+6y)\vec{i}+(6x-2yz)\vec{j}+(3x^2z^2-y^2)\vec{k}$ is conservative vector field and find its scalar potential function. [5]

13. Evaluate $\iint_S \vec{F}.\hat{n}\,ds$ where $\vec{F}=x^2\vec{i}+y^2\vec{j}+z^2\vec{k}$ and S is the finite plane x+y+z=1 between the co-ordinate planes. [5]

14. Using Green's theorem, find the area of the hypocycloid $\frac{x^{2/3}}{a^{2/3}}+\frac{y^{2/3}}{b^{2/3}}=1$. [5]

15. Evaluate $\iint_S \vec{F}.\hat{n}\,ds$ where $\vec{F}=2x\,\vec{i}+3y\,\vec{j}+4z\,\vec{k}$ and S is the surface of sphere $x^2+y^2+z^2=1$ by Gauss divergence theorem. [5]

OR

Verify Stoke's theorem for $\vec{F}=2y\,\vec{i}+3x\,\vec{j}-z^2\vec{k}$ where S is the upper half of the sphere $x^2+y^2+z^2=9$ and 'C' is its boundary. [5]

$\iint \vec{F}\cdot\hat{n}\,ds = \iint \vec{F}\cdot\hat{n}\,\frac{dx\,dy}{|\hat{k}\cdot\hat{n}|}$

*** $\hat{n}$ = normal to the given surface

$\therefore \vec{n}$ = grad of S

$= \frac{\partial}{\partial x}x^2 i + \frac{\partial}{\partial y}y^2 j + \frac{\partial}{\partial z}z^2 k$

$= 2xi+2yj+2zk$

$\therefore \hat{n} = \frac{2}{\sqrt{12}} = \frac{1}{\sqrt{3}}(xi+yj+zk)$

. 02 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B.Arch)	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Engineering Mathematics III *(SH501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Find the value of the determinant $\begin{vmatrix} a^2 & a^2-(b-c)^2 & bc \\ b^2 & b^2-(c-a)^2 & ca \\ c^2 & c^2-(a-b)^2 & ab \end{vmatrix}$ [5]

2. Show that the matrix $B^{\theta}AB$ is Hermitian or skew-Hermittian according as A is Hermitian and skew- Hermitian. [5]

3. Find the rank of the matrix $\begin{bmatrix} 6 & 1 & 3 & 8 \\ 4 & 2 & 6 & -1 \\ 10 & 3 & 9 & 7 \\ 16 & 4 & 12 & 15 \end{bmatrix}$ reducing this into the triangular form. [5]

4. Obtain the characteristic equation of the matrix $A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$ and verify that it is satisfied by A. [5]

5. Evaluate $\int_c \vec{F}.\vec{dr}$, where $\vec{F} = (x-y)\vec{i} + (x+y)\vec{j}$ along the closed curve C bounded by $y^2 = x$ and $x^2 = y$ [5]

6. Find the value of the normal surface integral $\iint_S \vec{F}.\vec{n}\,ds$ for $\vec{F} = x\vec{i} - y\vec{j} + (z^2-1)\vec{k}$, where S is the surface bounded by the cylinder $x^2+y^2=4$ between the planes $Z=0$ and $Z=1$. [5]

7. Using Green's theorem, find the area of the astroid $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$ [5]

8. Verify stoke's theorem for $\vec{F} = 2y\vec{i} + 3x\vec{j} - z^2\vec{k}$ where S is the upper half of the sphere $x^2+y^2+z^2=9$ and C is its boundary. [5]

OR

Evaluate the volume intergral $\iiint_V \vec{F}\,dv$, where V is the region bounded by the surface $x=0, y=0, y=6, z=x^2, z=4$ and $\vec{F} = 2xz\vec{i} - x\vec{j} + y^2\vec{k}$

9. Find the Laplace transforms of the following functions [2.5×2]
   a) $t\,e^{-4t}\sin 3t$
   b) $\dfrac{\cos at - \cos bt}{t}$

10. State and prove the second shifting theorem of the Laplace transform. [5]

11. Solve the following differential equation using Laplace transform. [5]

$$\frac{d^2y}{dx^2}+\frac{dy}{dx}-2y=x \text{ given } y(0)=1,\ y'(0)=0$$

12. Obtain the Fourier series for $f(x) = x^2$ in the interval $-\pi < x < \pi$ and hence show that [5]

$$\sum\frac{1}{n^2}=\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\ldots\ldots=\frac{\pi^2}{6}$$

13. Express $f(x) = x$ as a half-range sine series in $0 < x < 2$ [5]

14. Maximize $Z = 4x_1+5x_2$ subject to constraints [5]

$2x_1 + 5x_2 \leq 25$

$6x_1 + 5x_2 \leq 45$

$x_1 \geq 0$ and $x_2 \geq 0$

$4 \times \frac{45}{6}$ $(0, 9)$

graphically

15. Solve the following linear programming problem using the simplex method. [10]

Maximize $P = 50x_1+80x_2$

Subject to $x_1+ 2x_2 \leq 32$

$3x_1 + 4x_2 \leq 84$

$x_1, x_2 \geq 0$

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02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BEL, BEX, BCT, BME, BIE, B. AGRI.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: **- Engineering Mathematics III *(SH 501)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. Prove that: $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}^2 = \begin{vmatrix} 2bc-a^2 & c^2 & b^2 \\ c^2 & 2ac-b^2 & a^2 \\ b^2 & a^2 & 2ab-c^2 \end{vmatrix} = (a^3+b^3+c^3-3abc)^2$. [5]

2. Define Hermition and Skew Hermition matrix. Show that every square matrix can be uniquely expressed as the sum of a Hermition and a skew Hermition. [5]

3. For what value of λ the equation $x + y + z = 1$, $x + 4y + 10z = \lambda^2$ and $x + 2y + 4z = \lambda$ have a solution? Solve them completely in each case. [5]

4. Find the eigen values and eigen vectors of $A = \begin{vmatrix} 3 & -4 & 4 \\ 1 & -2 & 4 \\ 1 & -1 & 3 \end{vmatrix}$. [5]

5. Evaluate $\int_C \vec{F}.\vec{dr}$, Where C: $x^2 = y$ and $y^2 = x$ and $\vec{F} = (x-y)\vec{i} + (x+y)\vec{j}$. [5]

6. State and prove Green theorem in a plane. [5]

7. Verify Guess divergence theorem for $\vec{F} = x^2\vec{i} + 3\vec{j} + yz\vec{k}$. Taken over the cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$. [5]

8. Find the Laplace transform of the given function (i) $t^2 \sin t$ (ii) $\cos at \sinh at$. [5]

9. Evaluate $\iint_s \vec{F}.\hat{n} ds$ where $\vec{F} = 3\vec{i} + x\vec{j} - yz\vec{k}$ and s is the surface of the cylinder $x^2 + y^2 = 9$ included in the first octant between the plane $z = 0, z = 4$. [5]

10. Find the inverse Laplace transform: (a) $\frac{1}{(S-2)(S+4)}$ (b) $\log\left(\frac{s^2+a^2}{s^2}\right)$ [5]

11. Solve the equation using Laplace transform $y'' + 4y' + 3y = t$, $t>0$ $y(0) = 0$, $y'(0) = 1$. [5]

13

12. Obtain a Fourier series to represent the function $f(x) = /x/$ for $-\pi \le x \le \pi$ and hence deduce $\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots\dots$ [5]

13. Obtain the half Range Sine Series $f(x) = ex$ in $0<x<1$. [5]

OR

Obtain the Fourier series for $f(x) = x - x^2$ where $-1 < x < 1$ as a Fourier series of period 2. [7.5]

14. Solve the following by using the simplex method:

Maximize $P = 15x_1 + 10x_2$,
Subject to
$2x_1 + x_2 \le 10$,
$x_1 + 3x_2 \le 10$,
$x_1, x_2 \ge 0$. [7.5]

15. Solve by using the dual method:

Minimize $C = 21x_1 + 50x_2$,
Subject to $2x_1 + 5x_2 \le 12$,
$3x_1 + 7x_2 \le 17$,
$x_1, x_2 \ge 0$.

OR

Solve the following LPP by using the big M-method:

Maximize $P = 2x_1 + x_2$,
Subject to
$x_1 + x_2 \le 10$,
$-x_1 + x_2 \ge 2$,
$x_1, x_2 \ge 0$.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH 505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Meat products are regularly monitored for freshness. A trained inspector in Kathmandu Metropolitan selects a sample of the product and assigns an offensive smell score between 1 and 7 where 1 is very fresh. The resulting offensive smell scores for each of 16 samples are

   3.2, 3.9, 1.7, 5.0, 1.9, 2.6, 2.4, 5.3, 1.0, 2.7, 3.8, 5.2, 1.0, 6.3, 3.3, 4.3

   Construct a box-plot, interpret the result and comment on the shape of the distribution. [6]

2. Define Baye's Theorem for conditional Probability. A box containing 5000 IC chips, of which 1000 are manufactured by company A and the rest by company B. Ten percentage of chips made by company A and five percentage of chips by company B are defective. If we select a chip at a random
   a) What is the probability that the chip chosen is defective?
   b) If a randomly chosen chip is found to be defective, what is the probability that is comes from company A. [6]

3. Define random variable. Differentiate between discrete random variables and continues random variables with suitable example. [5]

4. Compare Binomial and Negative Binomial distribution including similarity and difference with suitable examples. [5]

5. If X is a continuous random variable with probability density function $f(x) = x/8$ or $3 < x < 5$.
   a) Find the probability for $P(1 < x < 2.5)$
   b) Determine the mean and standard deviation for x. [5]

6. If height of the doors in traditional house in a cultural city follow normal distribution, 73% of the doors has height above 58 inches and 18% of the doors has height over 63 inches. Find the mean and the standard deviation of the height of the doors. [5]

7. Discuss the following terms in statistics population, sample, parameter and statistic with suitable example. [5]

8. From the population of size 5 as: 22, 23, 24, 25 and 26.
   a) List out all the samples of size three without replacement.
   b) Find the sample mean of each samples.
   c) Prove that, sample mean is unbiased mean of population mean.
   d) Also find the standard error of sample mean. [5]

9. Explain clearly the major steps to be adopted by researchers in testing of hypothesis of single mean for small sample. [5]

10. A social worker believes that fewer than 25% of the married couples in a certain area of Nepal ever used any form of birth control. A random sample of 120 couples was contacted 25 of them said they had used same method of birth control. Test and comment the social worker's belief at $\alpha = 5\%$. [5]

11. A company manufacturing company has three types of computers. The cost (in thousand rupees) for each type of computer is given in the following table. Using ANOVA, test whether the average cost per computer is considerably different across three types of computer at 5% level of significance? [5]

Type C_1	Type C_1	Type C_1
83	56	79
83	76	95
76	72	87

12. To determine whether there is really relationship between an employee's performance in the training program and his ultimate success in the job, it takes a sample of 400 cases from its very extensive files and obtains the result shown in the following table: [χ^2-value is 9.488]

Success in job	Performance in training program		
	Below average	Average	Above average
Poor	23	60	29
Average	28	79	60
Very good	9	49	63

Use the 0.05 level of significance to test whether performance in training program and success in the job are independent. [5]

13. Define partial correlation with examples. A sample of 10 values of three variables X_1, X_2 and X_3 were obtained as

$\sum X_1 = 10$	$\sum X_2 = 10$	$\sum X_3 = 10$
$\sum X_1^2 = 20$	$\sum X_2^2 = 68$	$\sum X_3^2 = 170$
$\sum X_1X_2 = 10$	$\sum X_2X_3 = 64$	$\sum X_1X_3 = 15$

Find Partial correlation coefficient between X_2 and X_3 eliminating the effect of X_1. [5]

14. The grams of solids removed from a material (y) is thought to be related to the drying time (x). Ten observations obtained from an experimental study follow: [5]

y	4.3	1.5	1.8	4.9	4.2	4.8	5.8	6.2	7.0	7.9
x	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0

a) Construct the scatter plot.
b) Calculate correlation coefficient.
c) Draw your construction on relation of solid removal and drying time.

15. Temporary or permanent hearing loss from occupational noise exposure is one of the most common of all industrial diseases. Generally, 85-90 dB over an eight-hour workday is the allowable level of noise, although it is better to reduce noise even further, whenever possible. A sample of 50 individuals working at a perticular industry was selected and the noise level (dB) experienced by each individual was determined, yielding the following data:

55.3, 55.3, 55.3, 55.9, 55.9, 55.9, 55.9, 56.1, 56.1, 56.1, 56.1, 56.1, 56.1, 56.8, 56.8, 57.0, 57.0, 57.0, 57.8, 57.8, 57.8, 57.9, 57.9, 57.9, 58.8, 58.8, 58.8, 59.8, 59.8, 59.8, 62.2, 62.2, 63.8, 63.8, 63.8, 63.9, 63.9, 63.9, 64.7, 64.7, 64.7, 65.1, 65.1, 65.1, 65.3, 65.3, 65.3, 65.3, 67.4, 67.4

a) Find mean, standard deviation of the noise level at the industry and interpret the results.
b) Construct 95% confidence interval on true mean noise level at the industry.
c) Interpret your findings. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH 505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary taes are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Describe the various measures of central tendency. The following table represents the marks of 100 students. [

Marks	0-20	20-40	40-60	60-80	80-100
No. of Students	14	18	27	26	15

Find the mean, median and standard deviation of all 100 students.

2. State the law of addition of probability. If there are three candidates for the position of principal X, Y, Z whose chances of getting the appointments are in ratio 4/9, 2/9, 3/9. The probability that X if selected would introduce co-education in the college is 0.3. The probability of Y and Z doing the same are respectively 0.5 and 0.8. What is the probability that there was co-education in the college? [2+

3. Define Binomial distribution. Under what condition Binomial distribution can be approximate by Pisson distribution? [

4. A hospital administrator, who has been studying daily emergency admissions over a period of several years, has concluded that they are distributed according to the Poisson Law. Hospital records reveal that emergency admissions have averaged three per day during this period. If the administrator is correct in assuming a Poisson distribution, find the probability that [5

   a) Exactly two emergency admissions will occur in a given day.
   b) No emergency admissions will occur in a given day.
   c) Either three or four emergency cases will be admitted on a particular day.

5. Describe the conditions for the probability density function. The length of time (in minutes) that a certain lady speaks on the telephone is found to be random phenomenon, with a probability function specified by the probability density function f(x) as

$$f(x) = \begin{cases} Ae^{-x/5} & \text{for } x \geq 0 \\ 0 & \text{elsewhere} \end{cases}$$

Find the value of A. what is the probability that the number of minutes that she will take over the phone is [5]

   a) more than 10 minutes; b) less than 5 minutes and
   c) between 5 and 10 minutes.

6. The breakdown voltage X of a randomly chosen diode of aparticular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be

   a) between 39 and 42 volts
   b) less than 44 volts
   c) more than 43 volts [5]

OR

The daily consumption of electric power in a certain city follow a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the power plant of this city has daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day?

7. Define parameter, statistic and sampling with suitable examples. Define standard error of mean. [5]

8. Define Central Limit Theorem. If the mean and standard deviation of serum iron values for healthy men are 120 and 15 micrograms per 100 ml, respectively, what is the probability that are random sample 50 normal men will yield a mean between 115 and 125 micrograms per 100 ml? [5]

9. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces.

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

a) Fit the regression equation of performance rating on experience and estimate the probable performance of an operator had 8 years experience.

b) Determine coefficient of determination and interpret it. [5]

10. What are two regression coefficients and what do they represent? Write the properties of regression coefficients. [5]

11. Explain clearly the major steps to be adopted by researchers in testing hypothesis. [5]

12. Four brands of flashlights batteries are to be compared by testing each brand in five flashlights. Twenty flashlights are randomly selected and divided randomly into four groups of five flashlights each. Then each group of flashlights uses a different brand of battery. The lifetimes of the batteries, to the nearest hour, are as follows.

Brand A	42	30	39	28	29
Brand B	28	36	31	32	27
Brand C	24	36	28	28	33
Brand D	20	32	38	28	25

At the 5% significance level, does there appear to be a difference in mean lifetime among the four brands of batteries? [5]

13. From the following data can you conclude that there is association between the purchase of brand and geographical region? [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

Use 5% level of significance.

14. Transceivers provide wireless communication among electronic components of consumer products. Responding to a need for a fast, low-cost test of Bluetooth-capable transceivers, engineer developed a product test at the wafer level. In one set of trails with 60 devices selected from different wafer lots, 48 devices passed. Test the null hypothesis $p = 0.70$ against the alternative hypothesis $p > 0.70$ at 5% level of significance. [5]

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic. [8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

a) Find sample mean, sample variance and sample standard deviation.

b) Compute a value that measures the amount of variability relative to the value of mean.

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Probability and Statistics (*SH 505*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary figures are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Following table provide the information regarding the number of customers registered in two cyber cafe for 10 randomly selected days. [6]

   a) Find the average number for customers registered in two cafes.

   b) Which cyber cafe's registration is more consistent and why

Cafe A	210	221	234	312	199	345	309	289	333	279
Cafe B	321	154	234	275	356	304	311	267	281	199

2. Define conditional probability. A factory production line is manufacturing bolts using three machines, A B and C. Of the total output, machine A is responsible for 25%, machine B for 35% and machine C for the rest. It is known from previous experience with the machines that 5% of the output from machine A is defective, 4% from machine B and 2% from machine C. A bolt is chosen at random from the production line and found to be defective. What is the probability that it came from (i) machine A (ii) machine B (iii) machine C? [6]

3. Under which condition binomial distribution tends to Poisson distribution? If 2% of electric bulbs manufactured by a certain company are defective. Find the probability that in a sample of 200 bulbs (i) less than 2 bulbs (ii) more than 3 bulbs are defective. [5]

4. Why negative binomial distribution is known as converse of binomial distribution? In which conditions negative binomial distribution is suitable to use? Write the dissimilarities between binomial and negative binomial distributions. [5]

5. A random variable X has the probability density function f(x) as

$$f(x)=\begin{cases} kx\, e^{-\frac{x^2}{7}}, x\geq 0 \\ 0, \text{otherwise,} \end{cases}$$

   a) Find the value of k if f(x) prove that given function is probability density function.

   b) Find the mean and variance of random variable X [5]

6. Define Gamma probability distribution. Under what conditions it is used? Write its characteristics. [5]

7. Define central limit theorem. Write its applications. An unknown distribution has a mean of 90 and a standard deviation of 15. Samples of size n = 64 are drawn randomly from the population. Find the probability that the sample mean is between 85 and 92. [5]

8. Define sampling distribution. Prove that sampling distribution of sample mean is unbiased estimator of the population mean. Also obtain the expression for standard error of sample mean when the population is infinitely large. [5]

9. The following are the Brinell hardness value obtained for 10 samples of magnesium alloy-I and 12 sample of Magnesium alloy- II Use the 1% level of significance to test the hypothesis that mean hardness in the population are same or not? [5]

Alloy I	66.3	63.5	64.9	61.8	64.3	64.7	65.1	64.5	68.4	63.2	-	-
Alloy II	71.3	60.4	62.6	63.9	68.8	70.1	64.8	68.9	65.8	66.2	67.2	69.4

10. Define Hypothesis and write down the steps involve in the test of significance of Paired test. [5]

11. 300 employees of a company were selected at random and asked whether they were in favor of a scheme to introduce flexible working hours. The following table shown the opinion and the departments of the employees. [5]

	OPINION		
Department	In favor	Uncertain	Against
Production	89	42	9
Sales	53	36	11
Administration	38	12	10

Test whether there is evidence of a significant association between opinion and department at 5% significance level.

12. The sponsor of a television 'special' expected that at least 40 percent of the viewing audience would watch the show in a particular metropolitan area. For a random sample of 100 households with television sets turned on 30 are viewing the 'special'. Can the sponsor's assumption that at least 40 percent of the households would watch the program be rejected at the (i) 10 percent and (ii) 5 percent level of significance? [5]

13. A sample of 10 values of three variables X_1, X_2 and X_3 were obtained as;

$\sum X_1=10$	$\sum X_2=20$	$\sum X_3=30$
$\sum x_1^2=20$	$\sum x_2^2=68$	$\sum x_3^2=170$
$\sum X_1 X_2=10$	$\sum X_1 X_3=15$	$\sum X_2 X_3=64$

Find

a) Partial correction between X_1 and X_2 eliminating the effect of X_3.

b) Multiple correlation coefficients between X_1, X_2 and X_3 assuming X_1 as dependent.

14. Distinguish between correlation coefficient and regression coefficient and write its importance in the field of engineering. [5]

15. From the following 33 pairs of bivariate observation (X,Y). [8]

X	63	80	63	47	85	50	63	53	70	76	54
	64	67	52	75	85	60	88	71	54	47	56
	85	47	70	53	74	79	85	82	68	52	75
Y	86	65	54	89	83	49	80	59	54	51	59
	85	54	65	50	67	71	56	79	71	49	65
	67	83	45	80	81	60	49	48	75	79	76

a) Find the sample mean, sample standard deviation and sample variance of each groups

b) Test the uniformity of each data.

c) Estimate the value of Y when the value of X is given as 92.

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2078 Kartik

Exam.	Back		
Level	BE	**Full Marks**	80
Programme	BEI	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Probability and Statistics *(SH 505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Nepal Telecom introduced the latest telecommunication technology, 4G/LTE (Long Term Evolution) to its GSM mobile subscribers for the first time in Nepal (in 2078 BS) and then found the following information about the subscribers in the month of Baishakh, 2078, at a particular place of Kathmandu Valley.

Age	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80
No. of subscribers	40	50	35	25	12	10

List the five-number summary and prepare a box-and-whisker plot from this information. Also, comment on the nature of frequency distribution. [6]

2. State Bayes' Theorem for conditional probability. An assembly plant receives its voltage regulators from these three different suppliers, 60% from supplier B_1, 30% from supplier B_2 and 10% from supplier B_3. It is also known that 95% of the voltage regulators from B_1, 80% of these from B_2 and 65% of these from B_3 perform according to specifications.

   a) What is the probability that any one voltage received by the plant will perform according to specifications?

   b) What is the probability that a voltage regulator that perform according to specifications came from supplier B_1. [6]

3. Write the differences and similarities between Binomial and Negative Binomial Distribution. [2+3]

4. A quality control engineer inspects a random sample of 4 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects. What are the probabilities that the inspector's sample will contain

   a) None of the batteries with defect?

   b) At least two of the batteries with defects?

   c) At most three of the batteries with defects? [5]

5. The distribution function for a random variable X is

   $F(x) = 1 - e^{-2x}$ for $x \geq 0$

   $= 0$ for $x < 0$

   a) Find $P(X > 2)$

   b) Find mean and variance of the variable X. [5]

6. Define Standard Normal Distribution. Write the area properties of normal distribution. [5]

7. Define standard error of sample mean. A population consists of the four numbers 12, 19, 13, 16.

   a) Write down all possible sample size of two without replacement.

   b) Find standard error of the sample mean. [5]

8. State Central Limit Theorem. The lifetime of a certain brand of an electric bulb may be considered a random variable with mean 1200 hours and standard deviation 250 hours. Find the probability that average lifetime of 60 bulbs.

   a) exceed 1400 hours

   b) is between 1100 hours and 1300 hours

   c) is less than 1100 hours [5]

9. Write properties of correlation coefficients. The zero order correlation coefficient for general intelligence test (X_1), online class test (X_2) and age (X_3) of students of a university in Nepal during COVID period are given as $r_{12} = 0.93$, $r_{13} = 0.50$ and $r_{23}=0.34$. Assuming the first variable X1 as dependent, compute the coefficient of multiple determination and interpret the result. [5]

10. The following table gives age and percentage of blindness in respective age interval.

Age (yrs)	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
% of blindness	70	63	21	26	45	31	46	80

a) Find the least squares line for predicting % of blindness from age.
b) Using the least-squares line, predict the actual % blindness if the age is 70 yrs. [5]

11. The sample average unrestrained compressive strength for 45 specimens of particular type of bricks was computed to be 3107 psi and sample standard deviation was 188 psi. The distribution of unrestrained compressive strength may be somewhat sewed. Does the data strongly indicate that the true average unrestrained compressive strength is less than design value of 3200? Test using 5% level of significance. [5]

12. Four trained operators work production of a new product. The productivity of the operators are recorded as below:

Operators	Production		
1	10	12	14
2	12	11	13
3	14	15	12
4	16	10	17

Using ANOVA, test whether the difference in average productivity due to the difference in operators are significant. Use $\alpha = 5\%$. [5]

13. Patients in a hospital are classified as surgical or medical. A record is kept of the number of times patients require nursing service during the night and whether or not these patients are on Medicare. The data are presented here:

	Patient Category	
Medicare	Surgical	Medical
Yes	620	380
No	550	450

Test the hypothesis (using $\alpha = 0.01$) that calls by surgical-medical patients are independent of whether the patients are receiving Medicare. [5]

14. What are the errors of test of hypothesis? Write the procedure of testing hypothesis of two population proportion. [5]

15. The entrance score of three engineering institutes are as follows: [8]

Institutes	Entrance scores								
A	740	800	830	840	860	890	830	930	1070
B	655	775	825	978	989	1025	950	980	1100
C	850	825	749	870	565	978	925	950	1000

a) Calculate mean and standard deviation for institute A, B and C.
b) Which institute is good?
c) Which institute is consistent?

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH 505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Following is the age distribution of 1000 persons working in a factory. [6]

Age Group	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60
No. of person	60	122	135	242	148	107	85	63	38

Due to heavy loss, the management decides to bring down the strength to 50 percent of the present number according to following scheme:

(i) to retrench the first 8% from the lower group
(ii) to absorb the next 32% in other branches.
(iii)to make 10% from highest age group retire premature.

What will be the age limits of the persons retained in the mill and of those transferred to other branches?

2. a) Define the terms: (i) Mutually exclusive events (ii) Independent events. [2]

b) Customers are used to evaluate preliminary product designs. In the past, 95% of highly successful products received good reviews, 60% of moderately successful products received good reviews, and 10% of poor products received good reviews. In addition, 40% of products have been highly successful, 35% have been moderately successful, and 25% have been poor products.

(i) What is the probability that a product attains a good review?
(ii) If a new design attains a good review, what is the probability that it will be a highly successful product? [4]

3. Define Hypergeometric Distribution. How does it differ from Binomial Distribution? Write the approximation condition for approaching Hypergeometric to Binomial Distribution. [5]

4. Three people toss a coin and odd man pays for the coffee. If the coins all turns up the same, they toss gain. Find the probability that fewer than 4 tosses are needed. [5]

5. Let the continuous random variable X denote the diameter of a hole drilled in a sheet metal component. The target diameter is 12.5 millimeters. Most random disturbances to the process result in larger diameters. Historical data show that the distribution of X can be modeled by a probability density function $f(x) = 20e^{-20(x-12.5)}$, $x \geq 12.5$. If a part with a diameter larger than 12.60 millimeters is scrapped,

a) What proportion of parts is scrapped?
b) What proportion of parts is between 12.5 and 12.6 millimeters? [5]

6. Under what conditions, the Poisson distribution can be approximated using Normal distribution. Of a large group of men, 5% are under 60 inches in height and 40% are between 60 and 65 inches. Assuming a normal distribution, find the mean height and standard deviation. [5]

7. Define the terms: [5]

   a) Parameter, statistic
   b) Sample
   c) Sampling distribution of mean
   d) Standard error of mean?

8. An auditor for a large credit card company, knows that on average, the monthly balance of any given customer is 112 and the standard deviation is 56. If the audits 50 randomly selected accounts, what is the probability that the sample average monthly balance is (a) below 100 (b) between 100 and 130? [5]

9. Define the correlation coefficients and state its important properties. [5]

10. An investigation of the relationship between traffic flow x (1000's of cars per 24 hours) and lead content y of bark on trees near the highway (μg/g dry wt.) yielded the following data: [5]

Xi	8.3	8.3	12.1	12.1	17.0	17.0	17.0	24.3	24.3	24.3	33.6
Yi	227	312	362	521	640	539	728	945	738	759	1263

   a) Find the estimated regression line to estimate lead content from traffic flow.
   b) Compute a 95% confidence interval for the slope of the true regression line.

11. It is claimed that an automobile is driven on the average is 12000 miles per year. To test this claim a random sample of 100 automobile owners are asked to keep a record of the miles they travel. Would you agree that average miles driven is greater than claimed value if the random showed an average of 14,500 miles and a standard deviation of 8,000 miles? Use a 0.01 level of significance. [5]

Or,

I is claimed that a new diet will reduce a person's weight by 10 pounds on the average in a period of 2 weeks. The weights of seven women who followed this diet were recorded before and after a 2 week period.

Woman	1	2	3	4	5	6	7
Weight Before	129	133	136	152	141	138	125
Weight After	130	121	128	137	129	132	120

Test the manufacturer's claim at 5% level of significance.

12. A study compared the number of hours of relief provided by five different brands of antacid administered to 25 different people, each with stomach acid considered strong. The results are given below. [5]

Brand				
A	B	C	D	E
4.6	5.2	5.9	2.7	4.3
4.5	4.9	4.9	2.9	3.8
4.1	4.7	4.6	3.9	5.2
3.8	4.6	4.3	4.3	4.4

Calculate the F ratio. At the 0.05 level of significance, do the brands produce significantly different amounts of relief to people with strong stomach acid?

13. A random sample of 200 married men, all retired, were classified according to education and number of children. [5]

Education	Number of children		
	0-1	2-3	over 3
Elementary	14	37	32
Secondary	19	42	17
College	12	17	10

Test the hypothesis at 0.05 level of significance, that the size of the family is independent of the level of education attained by the father.

14. A random sample of 100 men and 100 women at a college is asked if they have an automobile on campus. If 31 of the mean and 24 of the women have cars, can we conclude that more men than women have cars on the campus? Use a 0.01 level significance. [5]

15. The following are the annual maximum flows in m^3/s in a river for 52-year period: [8]

1980	3120	2120	1700	2550
1700	1570	2830	2120	2410
1420	1980	2690	3260	1840
1980	4960	2120	2550	4250
2690	2270	5660	5950	3400
8500	3260	3960	2270	2410
2550	1980	2120	2410	3170
2410	1840	3120	3290	4550
1980	4670	1700	2410	3310
3120	2070	1470	2410	1130
3230	3090			

a) Find descriptive statistics: maximum, minimum, sample mean, range, sample standard deviation, standard error of mean.

b) Find approximate a 95% confidence interval for true average of rate of maximum flow.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BAG	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH 602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt* ***All*** *questions.*
- ✓ *The figures in the margin indicate* ***Full Marks***.
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Describe the strong and weak points of various measures of Central tendency. From the following frequency distribution find the range of income of middle 70% of the employees and the median income. Also find mean deviation from mean. [6]

Income in Rs.	500-600	600-700	700-800	800-900	900-1000
No. of employees	150	300	500	200	50

2. Distinguish between absolute and relative measures of dispersion. The running capacity of two horses is given below, state which is more consistent and why? [5]

Horse A	250	255	280	290	295	300
Horse B	280	282	290	295	298	295

3. If we the following probability density function.

$$f(x) = \begin{cases} k(5+2x), & 2 \le x \le 4 \\ 0, & \text{otherwise} \end{cases}$$

Find the value of K and mean and variance of random variable X. [5]

4. A random variable X has following probability function.

X	-2	-1	0	1	2	3
P(X)	K	0.1	0.2	2k	3k	0.1

i) Find the value of K.
ii) Find Mean and Variance. [6]

5. During one stage in the manufacture of integrated circuit chips, a coating must be applied. If 70% of chips receive a thick enough coating, find the probability that among 15 chips (i) at least 12 will have thick enough coatings; (ii) at most 3 will have thick enough coatings; (iii) exactly 10 will have thick enough coatings. [5]

6. In a normal distribution 31% of the items are under 45 and 8% are over 64. Find the mean and standard deviation of distribution. (Given, $Z_{0.42}=1.4$, $Z_{0.19}=0.5$) [5]

7. Describe the advantages of sample surveys over complete enumeration? [6]

Nepal Electricity Authority wishes to estimate the average electric bills for the month of October for single family homes in Kathmandu. Based on similar studies in other cities the standard deviation is assumed to be Rs. 150. The NEA wants to estimate the average bill for October such that error will not deviate by Rs. 15 with 90% confidence. What sample size is needed?

8. What are the assumptions for the t-test? Describe the procedure of test of significance between two means for small sample. [5]

9. A research company has designed three different systems to clean up oil spills. The following table contains the results, measured by how much surface area in square meters is cleared in one hour. The data were found by testing each method in several trials. Are the three systems equally effective? Use the 0.05 level of significance. [5]

System A	55	60	63	56	59	55
System B	57	53	64	49	62	-
System C	66	52	61	57	-	-

10. Test of the fidelity and selectivity of 190 digital radio receivers produced the results shown in the following table.

		Fidelity		
		Low	Average	High
Selectivity	Low	6	12	32
	Average	33	61	18
	High	13	15	0

Use α=0.05and x^2 = 5.991 to test whether there is relationship between fidelity and selectivity. [6]

11. Define Hypothesis, and write down the steps involve in the test of significance of difference of proportion. [5]

12. In 1990, 5.8% job applicants who were tested for drugs failed the test. At the 0.05 significant level, the test claim that the failure rate is now lower if a simple random sample of 1520 current job applicants results in 58 failure. Does the result suggest that fewer job applicants now use drugs? [5]

13. Fit the regression line of yield of crop ('000 tones) on amount of rainfall (mm) and amount of fertilizers used (kg). Also estimate the yield of crop for the year in which rainfall is 13 mm and fertilizer used is 9 kg. [5]

Yield	4	6	7	9	13	15
Rainfall	3	4	6	8	12	15
Fertilizer	4	10	14	20	24	30

14. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces.

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

a) Fit the regression equation of performance rating on experience and estimate the probable performance of an operator had 8 years experience.

b) Determine coefficient of determination and interpret it. [5]

15. List Five Number summary and prepare the box plot for numbers of guest registered each of 60 randomly selected days. [6]

108	94	188	116	165	181	106	133	176	110
169	134	129	109	85	124	119	165	153	135
105	180	105	91	117	148	83	96	101	123
128	143	136	99	169	133	89	90	174	144
151	168	103	116	106	107	179	113	172	120
179	183	99	94	87	120	154	159	103	139

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BAG	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH 602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *__Necessary tables are attached herewith.__*
- ✓ *Assume suitable data if necessary.*

1. Write down the significance of statistics in engineering. An experiment shows the height of 51 plants given below. If average heights of all the 51 plants are 40 cm find the missing frequencies corresponding to the height 30 and 50cm. [6]

Height (cm)	10	20	30	40	50	60
No. of plant	2	3	-	21	-	5

2. What do you mean by mutually exclusive, exhaustive and complementary events? Explain with examples. In a particular city, airport A handles 50% of all airlines traffic, airport B handles 30% and airport C handles 20%. The detection rates for weapons at the three airports are 0.9, 0.5 and 0.4 respectively. A passenger is randomly selected at one of the airports. Then (i) what is the probability that he/she carrying a weapon? (ii) If he/she is found to be carrying a weapon, what is the probability that airport A is being used? [5]

3. Define probability density function? A continuous probability distribution of a variable x is defined as $f(x)=KX(1-X)$ for all $0 \le X \le 1$. Compute (i) $P(X \ge 0.4)$ (ii) $P(\frac{1}{4} \le X \le \frac{3}{4})$ [5]

Or,

A fair dice was rolled until one gets a Six; find the expected number of toss required?

4. Define Negative Binomial distribution and explain characteristics. How does it differ from binomial distribution? [6]

5. A typist made 2.6 mistakes per page on average, find the probability that in the page typed by him, i) there is no mistake ii) at least two mistakes iii) at most 3 mistakes. [5]

6. Define Gamma distribution, chief characteristics and write its applications. [5]

Or,

The breakdown voltage X of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and s.d. 1.5 volts. What is the probability that the breakdown voltage will be (a) between 39 and 42 volts; (b) at most 43 volts; (c) at least 39 volts.

7. Define estimation? Write characteristics of a good estimator? A sample of 400 students taking Entrance for BE revealed an average score of 56. Construct a 95% as well as 99% confidence interval for population mean score if standard deviation of score of all students in known to be 10. [6]

8. A whole sale dealer wanted to buy a large quantity of light bulbs from two brands label A and B. He bought 100 bulbs from each bulbs brand and found by testing that brand A had mean life time 1120 hours and standard deviation 75 hours and brand B had mean life

time 1062 hours and standard deviation 82 hours. Find the 95% and 99% confidence limits for the difference in the average life of bulbs from the two brands. [5]

9. The following are the breaking strength of three different brands of cables.

Brand	Breaking Strength					
A	40	30	50	60	30	-
B	60	40	55	65	-	-
C	60	50	70	65	75	40

Construct ANOVA table and test for the equality of the average breaking strength of cables at α=5%. [5]

10. In a recent survey 1,072 Engineers were classified according to their intelligence (GPA in Bachelor) and economic conditions after graduation. Test whether there is any association between intelligence and economic condition. [6]

Economic Condition after graduation	Intelligence in BE			
	Excellent	Good	Mediocre	Dull
Good	48	199	181	82
Not good	81	185	190	106

x^2 value for 2 d.f.=5.991

11. What is testing of hypothesis? Explain the procedure followed in testing of Significance difference between two population proportion large sample? [5]

12. A simple random sample of Household with TV set in use. Show that 1024 of them were tuned to 60 minute while 3836 were tuned to some other show. Use 0.05 significant level to test the claim of CBS executive that "60 minute get more than a 20 shave", which mean that more than 20% of set in use are tuned to 60 minute. [5]

13. A sample of 10 values of three variables X1, X2 and X3 were obtained as

$\Sigma X_1=10$	$\Sigma X_2=20$	$\Sigma X_3=30$
$\Sigma X_1^2=20$	$\Sigma X_2^2=68$	$\Sigma X_3^2=170$
$\Sigma X_1X_2=10$	$\Sigma X_1X_3=15$	$\Sigma X_2X_3=64$

Find (i) Partial correlation between X_1 and X_2 eliminating the effect of X_3 (ii) Multiple correlation between X_1, X_2 and X_3 assuming X_1 as dependent variable. [5]

14. Differentiate between correlation and regression? From following data find the Karl Pearsons coefficient correlation and interpret the result? [5]

Marks in Statistics	39	65	62	90	82	75	25	98	36	78
Marks in Mathematics	47	53	58	86	62	68	60	91	51	84

15. Following data reveals the sample of 22 pairs of observation (X,Y) drawn from large population.

X	46	61	56	68	58	45	50	59	45	66	57
Y	49	46	43	32	26	27	29	47	37	30	43
X	59	66	62	57	57	45	50	61	55	47	51
Y	32	27	37	24	43	49	48	29	37	32	26

i) Find the sample mean for each variable X and Y.
ii) Which series is more consistent and why?
iii) Find the standard error of the difference of mean.
iv) Find the coefficient of Karl Pearson correlation. [6]

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INSTITUTE OF ENGINEERING

Examination Control Division

2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *__Necessary tables are attached herewith.__*
- ✓ *Assume suitable data if necessary.*

1. Define measures of central tendency and measures of variance. Following data gives the distribution of marks of 50 students in statistics.

Marks more than	10	20	30	40	50	60	70
No. of students	50	45	35	20	10	4	1

Compute median marks. Also compute minimum marks obtained by a pass candidate if 60% student pass in the test. [6]

2. A problem in statistics is given to three students A, B and C whose chances of solving are ½, ¾ and ¼ respectively. If all of them try independently, what is the probability that

   a) at least one of them will solve it
   b) none of them can solve it
   c) exactly two of them can solve it [6]

3. Define binomial distribution and explain the condition for Binomial distribution. [2+2]

4. If the probability that an individual suffers a bad reaction from a certain injection is 0.001, among 2000 individual

   a) obtain probability distribution function for suffering bad reaction
   b) determine the probability that
   (i) exactly 3 individuals will suffer bad reaction
   (ii) more than 2, individuals will suffer bad reaction [6]

5. The breakdown voltage x of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and standard deviation 1.5 volts. What is the probability that the breakdown voltage. Will be

   a) Between 39 and 42 Volts
   b) At most 43 Volts
   c) At least 39 Volts [6]

OR

The distribution function for a random variable x is

$$f(x) = 1 - e^{-2x} \text{ for } x \geq 0$$
$$= 0 \text{ for } x < 0$$

a) Find $p(x > 2)$
b) Find mean and variance of the variable x.

6. Define discrete and continuous random variable. Also describe the procedure to compute mean and variance for both variables. [4]

7. Define standard normal distribution. Write down its properties and importance of this distribution. [4]

8. A population consists of four number 2, 8, 14, 20,
   a) Write down all possible sample size of two without replacement.
   b) Verify that the population mean is equal to the mean of the sample mean. [6]

9. What are difference between point estimation and Interval estimation? Also discuss differences between estimation and Hypothesis testing. [3+3]

10. Define critical value. A manufacturer claimed that at least 95% of the water pumps supplied to the ABC Company confirmed to specification. However, the product manager at ABC Company wasn't satisfied with the claim of the manufacturer hence to test the claim, the manager examined a sample of 250 water pumps supplied last month and found that 228 water pumps 45 per the specification. Can you conclude that the production manager is right to doubt on the claim of the manufactures ($\alpha = 0.01$) [6]

11. Three varieties of coal were analyzed by four chemists and the ash-content in the varieties were found as follows:

Varieties	Chemists 1	2	3	4
A	8	5	5	7
B	7	6	4	4
C	3	6	5	4

Test whether the varieties differ significantly in their ash-content? Test at 5% level of significance. [6]
[$F_{(2,9)} = 19.4$, $F_{(3,9)} = 8.81$].

12. Write the procedure of testing of Hypothesis for single proportion. [4]

13. The following data gives the number of twists required to break a certain kind of forged alloy bar and percentage of alloying element A present in the metal

Number of twists	41	49	69	65	40	50	58	57	31	36
Percentage of elements A	10	12	14	15	13	12	13	14	13	12

   a) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twists required break an alloy when percentage of element is 20
   b) Find 99% confidence interval for the regression coefficient. [4]

14. The simple correlation coefficient between fertilizer (x_1) seeds (x_2) and productivity (x_3) are $r_{12} = 0.59$, $r_{13} = 0.46$ are $r_{23} = 0.77$ calculate the partial correlation coefficient $r_{12.3}$ and multiple correlation $R_{1.23}$ [4]

15. The samples of length of life of bulbs from two companies are given below. [8]

Length of life (hours)	Company	
	A	B
500-600	10	3
600-700	21	8
700-800	6	15
800-900	8	12
900-1000	21	4
1000-1100	10	5
1100-1200	2	15
1200-1300	12	13
1300-1400	19	7
1400-1500	9	7
1500-1600	3	4
1600-1700	7	6
1700-1800	5	3
1800-1900	4	2
1900-2000	1	3

a) Calculate mean length of life of bulbs fro company A and company B
b) Calculate sample standard deviation and sample variance for given data
c) Which company is bulbs are more uniform?

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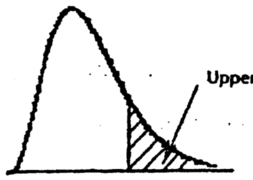
Table A3: Chi-squared Distribution



df	Upper Tail Probabilities 0.99	0.975	0.95	0.05	0.025	0.01
	Values of Chi-squared					
1	0.0002	0.0010	0.004	3.84	5.02	6.63
2	0.020	0.051	0.103	5.99	7.38	9.21
3	0.11	0.22	0.35	7.81	9.35	11.34
4	0.30	0.48	0.71	9.49	11.14	13.28
5	0.55	0.83	1.15	11.07	12.83	15.09
6	0.87	1.24	1.64	12.59	14.45	16.81
7	1.24	1.69	2.17	14.07	16.01	18.48
8	1.65	2.18	2.73	15.51	17.53	20.09
9	2.09	2.70	3.33	16.92	19.02	21.67
10	2.56	3.25	3.94	18.31	20.48	23.21
11	3.05	3.82	4.57	19.68	21.92	24.73
12	3.57	4.40	5.23	21.03	23.34	26.22
13	4.11	5.01	5.89	22.36	24.74	27.69
14	4.66	5.63	6.57	23.68	26.12	29.14
15	5.23	6.26	7.26	25.00	27.49	30.58
16	5.81	6.91	7.96	26.30	28.85	32.00
17	6.41	7.56	8.67	27.59	30.19	33.41
18	7.01	8.23	9.39	28.87	31.53	34.81
19	7.63	8.91	10.12	30.14	32.85	36.19
20	8.26	9.59	10.85	31.41	34.17	37.57
21	8.90	10.28	11.59	32.67	35.48	38.93
22	9.54	10.98	12.34	33.92	36.78	40.29
23	10.20	11.69	13.09	35.17	38.08	41.64
24	10.86	12.40	13.85	36.42	39.36	42.98
25	11.52	13.12	14.61	37.65	40.65	44.31
26	12.20	13.84	15.38	38.89	41.92	45.64
27	12.88	14.57	16.15	40.11	43.19	46.96
28	13.56	15.31	16.93	41.34	44.46	48.28
29	14.26	16.05	17.71	42.56	45.72	49.59
30	14.95	16.79	18.49	43.77	46.98	50.89
35	18.51	20.57	22.47	49.80	53.20	57.34
40	22.16	24.43	26.51	55.76	59.34	63.69
45	25.90	28.37	30.61	61.66	65.41	69.96
50	29.71	32.36	34.76	67.50	71.42	76.15

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INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: **- Probability and Statistics *(SH602)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. What are measures of central tendencies? Write favorable points of each of them. Calculate approximate measures of central tendency from following data; [1+2+3]

Wages in Rs/ week	Less than 35	35-37	38-40	41-43	Over 43
No. of wage earned	14	82	99	18	7

2. From a group of 4 Engineers, 3 Doctors and 2 Statistician a sub-group of 3 has to be made, what is the probability that sub-group consists of
   a) One from each profession
   b) Atleast one engineer [4]

3. Define discrete probability distribution with suitable example. Compare Negative Binomial and Binomial probability distributions. [3+3]

4. A quality control engineers inspects a random sample of 3 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects, what is the probabilities that the inspector's sample will contain
   a) None of the batteries with defect
   b) Only one of the batteries with defect
   c) At least two of the batteries with defect [6]

5. Write major characteristics of normal distribution. Discuss relation between Normal distribution and Standard Normal distribution. [2+3]

   OR

   What are Gamma and Chi-squared distributions? Specify relationship between them.

6. The life of an electric light bulbs follows Normal distribution with mean 800 hours and a standard deviation of 50 hours. Find the probability that a bulb burns
   a) Between 750 and 825 hours
   b) More than 900 hours [5]

   OR

   Define exponential distribution. Suppose that the service life of a semiconductor is exponentially distributed with an average of 60 hours. Find the probability that a semi-conductor will a) still working after 90 hours
   b) fail within 120 hours

7. A population consists of five numbers 2, 4, 6 and 8
   a) Enumerate all possible sample of size two without replacement
   b) Show that the mean of the sampling distribution of sample mean is equal to population mean [4]

8. State central limit theorem. A random sample of size 100 is taken from an infinite population with mean 75 and variance 256. Assert the chances of sample mean between 67 and 83. [6]

9. What is type Ist error? Describe the procedure of the for difference of two Mean for large sample. [6]

10. Define chi-square distribution. A book containing 500 pages, was thoroughly checked. The distribution of number of error page was given below as

Number of errors:	0	1	2	3	4	5
Number of pages:	275	138	75	7	4	1

Using chi-square test of goodness of fit, verify whether the arrivals follow a poison distribution at 5% level of significance. [6]

11. Define hypothesis. Describe the procedure of testing of hypothesis of significant difference between two population means for large samples.

OR

Describe the types of error in Hypothesis Testing. Write the procedure testing of Hypothesis of single proportion. [6]

12. Write the Decision criteria in test of Hypothesis with diagram. [4]

13. In trying to evaluate the effectiveness of antibiotics in killing bacteria, a research institute compiled the following information

Antibiotics (mg)	12	15	14	16	17	10
Bacteria	5	7	5.6	7.2	8.6	6.2

Find strength and direction of relationship between them. [4]

14. Differentiate between Correlation and regression analysis. [4]

15. Following data revels the scores of sixty candidates of IOE entrance examination

51.43	40	78.57	46.43	51.43	50.71
42.14	50.71	42.86	55	71.43	64.29
52.86	42.14	57.14	45.71	43.57	40
44.29	55.71	40	48.57	48.57	49.29
51.43	47.14	54.29	45	53.57	50
49.29	60	48.57	50.71	50	49.29
47.14	53.57	58.57	43.57	47.14	53.57
47.86	47.14	40	43.57	52.86	47.86
49.29	49.29	42.86	47.14	48.57	50
47.14	50.71	52.86	47.86	47.14	70

a) Estimate average score of candidates

b) Find unbiased estimator of true standard deviation and standard error of average score

c) Also test for consistency of score [8]

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22 TRIBHUVAN UNIVERSITY				
INSTITUTE OF ENGINEERING	**Exam.**	Back		
Examination Control Division	**Level**	BE	**Full Marks**	80
	Programme	BEL, BEX, BCT, B. Agri.	**Pass Marks**	32
2074 Ashwin	**Year / Part**	III / I	**Time**	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. What is Box plot and what does it measure? Explain the meaning of its different parts with diagram.

   A civil engineering monitors water quality by measuring the amount of suspended solids in a sample of river water. Over 11 weekdays, he observed 14, 12, 21, 28, 30, 63, 29, 65, 55, 19, 20 suspended solids (parts per million).

   Find the third quartile and interpret its meaning. [3+3]

2. Write sown the difference between the sample space and sample points, dependent and independent events. Urn A contains 2 white 1 black and 3 red balls. Urn B contain 3 white 2 black and 4 red balls. Urn C contain 4 white 3 black and 2 red balls. One Urn is choosen at random and 2 balls are drawn. They happen to be red and black. What is the probability that both come from Urn B. [6]

3. What are the characteristics of Binomial Distribution and how does it differ from Negative Binominal Distribution? [4]

4. A quality control engineer inspects a random sample of 4 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects. What are the probabilities that the inspector's sample will contain. [5]

   i) None of the batteries with defect?
   ii) At least two of the batteries with defects?
   iii) At most three of the batteries with defects?

5. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be [5]

   i) Between 39 and 42 volts
   ii) Less than 44 volts
   iii) More than 43 volts

   OR

   The daily consumption of electric power in a certain city follow a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the power plant of this city has daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day?

6. A college professor never finishes his lecture before the bell rings to end the period and always finishes his lectures within one minute after the bell rings. Let X = the time which elapses between the bell and the end of the lecture. Suppose that the p.d.f of X is [5]

$f(x) = kx^2, 0 \le x \le 1$

$= 0$, otherise

i) Find the value of k
ii) What is the probability that the lecture ends with ½ minute of the bell ringing?
iii) What is the probability that the lecture continues beyond the bell for between 15 and 30 seconds?

7. Define Central Limit Theorem. The amount of impurity in a batch of a certain chemical product is a random variable with mean value 4.0 gm and standard deviation 1.5 gm. If 50batches are independently prepared, what is the probability that the sample average amount of impurity is between 3.5 and 3.8 gm? [5]

8. Define population. Sample parameter and statistic with suitable examples. A population consists of 3,7,11,15. Consider all possible samples of size two which can be drawn without replacement from this population. Find population mean and Standard error of mean. [6]

9. What are the two regression coefficients and what do they represent when these two will be same? Write any three properties of regression coefficient. [5]

10. A sample of 8 values of three variables X_1, X_2 and X_3 were obtained as [5]

$\Sigma X_1 = 360$	$\Sigma X_2 = 64$	$\Sigma X_3 = 48$
$\Sigma X_1^2 = 17172$	$\Sigma X_2^2 = 546$	$\Sigma X_3^2 = 320$
$\Sigma X_1 X_2 = 2845$	$\Sigma X_1 X_3 = 2269$	$\Sigma X_2 X_3 = 396$

Find:

i) Partial correlation between X_1 and X_3 eliminating the effect of X_2
ii) Multiple correlation between X_1, X_2 and X_3 assuming X_3 as dependent

11. Discuss difference between estimation and hypothesis test of significance of population [5]

66.3	63.5	64.9	61.9	64.3	64.7	65.1	64.5	68.4	63.2

Find 99% confidence interval for true hardness of magnesium alloy.

12. An examination was given to 50 students at college A and 60 students at college B. At a mean grade was 75 with standard deviation of 9. At B mean grade was 79 with a standard deviation of 7. Is these significant difference between the performance of students at A and those at B, given that $\alpha = 0.05$? [6]

OR

Three randomly selected groups of chickens are fed on three different diets. Each group consists of five chickens. Their weight gains during a specified period of time are as follows:

Diet I	4	4	7	7	8
Diet II	3	4	5	6	7
Diet III	6	7	7	7	8

Test the hypothesis that mean gains of weight due to the three diets are equal.

P.T.O.

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B. Agri	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - **Probability and Statistics** *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Describe the various measures of central tendency and its application. The following table represents the marks of 100 students. [6]

Marks	0-20	20-40	40-60	60-80	80-100
No. of students	14	18	27	26	15

Find the mean, median and standard deviation of all 100 students.

2. Explain Baye's theorem. A chain of video stores sells three different brands of DVD players; Of its DVD players sales, 50% are brand 1 (the least expensive), 30% are brand 2, and 20% are brand 3. Each manufacturer offers a 1-year warranty on parts and labor. It is known that 25% of brand 1's DVD players require warranty repair work, where as the corresponding percentages for brands 2 and 3 are 20% and 10%, respectively. [2+4]

   a) What is the probability that a randomly selected purchaser has bought a brand 1 DVD players that will need repair while under warranty?
   b) What is the probability that a randomly selected purchaser has a DVD player that will need repair while under warranty?

3. Define negative binomial distribution with its important characteristics. [5]

4. If a publisher of nontechnical books takes great pains to ensure that its books are free of typographical errors, so that the probability of any given page containing at least one such error is 0.005 and errors are independent from page to page, what is the probability that one of its 400-page novels will contain. [5]

   a) Exactly one page with errors?
   b) At most three pages with errors?

5. In a certain examination test 2000 students appeared in Statistics. The average marks obtained were 50% and the standard deviation was 5%. How many students do you expect to obtain more than 60% marks? What are the minimum marks of the top 100 students? Assume that the marks are normally distributed. [5]

   OR

   The daily consumption of water in a certain place follow a gamma distribution with parameters $\alpha = 2$ and $\beta = 3$. If the daily capacity of this city is 9 million gallon of water, what is the probability that on any given day the water supply is inadequate?

6. The distribution function of a random variable x is [5]

$$F(x) = 1 - e^{-2x} \quad \text{for } x \geq 0$$
$$= 0 \quad \text{for } x < 0$$

   a) Find $P(x > 2)$
   b) Find mean and variance of the variable x.

7. What do you mean by central limit-theorem and discuss its applications. [4]

8. An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with mean equal to 800 hours and standard deviation of 40 hours. Find the probability that a random sample of 16 bulbs will have an average life of (a) less than 850 hours (b) between 750 to 900. [6]

9. Define partial and multiple correlation-with suitable examples. Write down the properties of partial and multiple correlation. [5]

10. Raw material used in the production of a synthetic fiber is stored in a place which has no humidity control. Measurements of the relative humidity in the storage place and moisture content of sample of the raw material (both in percentage) on 12 days yielded the following results: [5]

Humidity, X	42	35	50	43	48	62	31	36	44	39	55	48
Moisture content, Y	12	8	14	9	11	16	7	9	12	10	13	11

Verify that it is reasonable to fit a straight line. Fit the straight by the method of least squares.

11. Describe the procedure of the test of significance for difference of two properties for large sample. [5]

12. Six sample of each of four types of cereal grain grown in a certain region were analyzed to determine thiamin content, resulting in the following data (mg/g): [5]

Wheat	5.2	4.5	6.0	6.1	6.7	5.8
Barley	6.5	8.0	6.1	7.5	5.9	5.6
Maize	5.8	4.7	6.4	4.9	6.0	5.2
Oats	8.3	6.1	7.8	7.0	5.5	7.2

Does this data suggest that at least one of the grains differ with respect to true average thiamin content? Use 0.05 level of significance.

OR

A liquid dietary product implies in its advertising that use of the product for one month results in an average weight loss of at least 3 pounds. Eight subjects use the product for one month, and the resulting weight loss data are reported below. Do the data support the claim of the producer of the dietary product with the probability of a type I error set to 0.05?

Subjects	1	2	3	4	5	6	7	8
Weight (lb)	165	201	195	198	155	143	150	187
Weight (lb)	161	195	192	193	150	141	146	183

13. From the following data can you conclude that there is association between the purchase of brand and geographical region? [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

Use 5% level of significance.

14. Two different areas of a city are being considered as sites for day-care centers. Of 200 households surveys in one section, the proportion in which the mother worked full-time was 0.52. in another section, 40% of 150 households surveyed had mothers at full time jobs. At 0.05 level of significance, is there a significant difference in the proportion of working mothers in the two areas of the city? [5]

P.T.O →

23 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B. Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. In two companies A and B engaged in similar type of industry, the average weekly wage and standard deviation are given below: [6]

	Company A	Company B
Average weekly wage (Rs)	460	490
Standard deviation	50	40
No. of wage earners	100	80

   i) Which company pays larger amount as weekly wags?
   ii) Which company show greater variability in the distribution weekly wages?
   iii) What is the mean and standard deviation of all the workers in two companies taken together?

2. State the law multiplication of probability. An Electronics company has an engineering position open. The Probability that an applicant is capable is 0.7. Each applicant is given written test and oral examination. A capable applicant passes with Probability 0.9 while an incapable applicant passes with Probability of 0.4. Find (a) the probability that an applicant passes the test (b) the probability that the applicant is capable given he/she passes the test. [6]

3. Define negative Binominal Distribution. If a boy is throwing stone at a target what is the probability that his 10^{th} throw is his 5^{th} hit, if the probability of hitting the target at any trial is 0.6. Also find the mean and variance of random variable. [5]

4. Define hypergeometric probability distribution with an example. Describe the conditions for the binomial approximation to hypergeometric distribution? [5]

5. Let X denote the amount of time for which a book on two hour reserve at a college library is checked out by a randomly selected student and suppose that X has density function, [5]

   $f(x) = 1/2x, \quad 0 \leq x \leq 2$
   $\quad = 0 \quad$ otherwise

   Calculate $P(X \leq 1)$ and $P(0.5 \leq X \leq 1.5)$

6. Define continuous random variable with suitable example. Describe the properties of probability density function and distribution function. [5]

7. State Central limit theorem with an example. Explain why it is important in engineering field? [5]

8. A population consists of the four number 2,8,14,20 [5]

   i) Write down all possible sample size of two without replacement
   ii) Verify that the population mean is equal to the mean of the sample mean
   iii) Calculate the standard error of the sampling distribution of the sample mean

9. Define Karl Person coefficient of Correlation and coefficient of determination. What it is input in analysis. [5]

10. A house survey on monthly expenditure on food yield following data: [5]

Monthly expenditure (100 Rs.)	10	15	20	25	30	35	40
Monthly income (1000 Rs.)	2	4	5	7	6	6	5
Size of the family	4	5	7	10	8	11	4

Obtain the multiple correlation coefficient.

11. There was a research on voltage supply by Ba Hries supplied by two companies. Both company claims that same. But researcher suspects that there is significance difference between mean voltages between two companies. To test this, she selected independent samples from both company and in lab test the result were as follows: [5]

		Mean	Sample Standard deviation
Company A	13	3.59V	0.3V
Company B	10	3.15V	0.4V

Test the researcher suspect was correct at 5% level of significance.

12. Shyam and Co. produces three varieties of certain product: deluxe, find and ordinary. A recent market survey is conducted for preference of products. The preference was found as follow: [5]

Product	Production			
Deluxe	15	14	19	18
Fine	17	12	20	16
Ordinary	16	18	16	17

Is there a significant difference in the preference of products test it using ANOVA test. Use $\alpha = 5\%$

OR

The following are the average weekly losses of worker hours due to accidents in 10 industrial plan before and after a certain safety program was put into operation:

Before	45	73	46	124	33	57	83	34	26	17
After	36	60	44	119	35	51	77	29	24	11

Use the 0.05 level of significance to test whether the safety program is effective.

13. Define critical value. A manufacturer claimed that at least 95% of the water pumps supplied to the ABC Company confirmed to specification. However, the product manager at ABC Company wasn't satisfied with the claim of the manufacturer. Hence, to test the claim, the manager examined a sample of 250 water pumps supplied last month and found that 228 water pumps as per the specification. Can you conclude that the production manager is right to doubt on the claim of the manufactures? (α=0.01) [5]

14. Describe the Hypothesis testing procedure of Chi-square test of independence for 2×2 table. [5]

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic. [8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

a) Find sample mean, sample variance and sample standard deviation
b) Compare a value that measures the amount of variability relative to the value of mean

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22 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B. Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. What are the differences between measures of central tendency and measures of dispersion? The mean and standard deviation of 20 items is found to be 10 and 2 respectively. At the time of checking it was found that one item 8 was incorrect. Calculate the mean and standard deviation if: (i) the wrong item is omitted (ii) it is replaced by 12. [6]

2. Define conditional probability. An assembly plant receives its voltage regulators from these three different suppliers, 60% from supplier A, 30% from supplier B, and 10% form supplier C. It is also known that 95% of voltage regulators from A, 80% of these from B, and 65% these from C perform according to specifications. What is the probability that [6]
   i) Anyone voltage regulator received by the plant will perform according to specifications
   ii) A voltage regulator that perform according to specification came from B

3. Write the differences and similarities between Binomial and Negative Binomial Distribution. [2+3]

4. In certain factory turning out optical lenses, there is a small change, 1/500 for any lens to be defective. The lenses are supplied in packets of 10 each. What is the probability that a packet will contain [5]
   i) No defective lens
   ii) At least one defective lenses
   iii) At most two defective lenses

   OR

   Define mathematical expectation of a discrete random vasriable. A probability distribution is given.

X = x	0	1	2	3	4	5
p(X=x)	0.26	0.25	0.11	0.02	0.25	0.11

   Find (a) $P(X \geq 4)$; (b) $p(0 < X < 4)$; (c) mean and variance of X

5. Define standard normal distribution. Give the condition for normal approximation of Poisson distribution. [5]

6. The mean inside diameter of a sample of 200 washers produced by a machine is 0.502 cm and the standard deviation as 0.005 cm. The purpose for these washers are interned allows a maximum tolerance in the diameter of 0.496 to 0.508 cm, otherwise the washers are considered defective. Determine the percentage of defective washers produced by the machine. Assume the diameter is normally distributed. [5]

7. What do you mean by sampling distribution of a sample mean and its Standard Error? Explains with example. What would be the variance of sampling distribution of mean, if sample is taken from finite population? [5]

8. Define the Central Limit Theorem. A sample of 100 mobile battery cells tested to find the length of life produced the following results as mean 13 months and standard deviation of 3 months. Assuming the data to be normally distributed by using Central Limit Theorem what percentage of battery cells expected to have Average life? [5]

i) More than 15 months (ii) Less than 9 months

9. Define partial and multiple correlations with examples. Write down the properties of partial and multiple correlation. [5]

10. An article in wear (Vol.152, 1992, pp. 171-181) presents data on the fretting wear of mild steel and oil viscosity. Representative data follow, with x = oil viscosity and y = wear volume (10^{-4} cubic millimeters). [5]

y	240	181	193	155	172	110	113	75	94
x	1.6	9.4	15.5	20.0	22.0	35.5	43.0	40.5	33.0

i) Fit the sample linear regression model using least
ii) Predict fretting wear when viscosity x = 30

11. Describe the procedure of the test of significance for difference of two population mean for large sample. [5]

12. Ten objects were chosen at random from the large population and their weights were found to be in grams 63, 63, 64, 65, 66, 69, 65, 66.1, 64.5. In the light of above data, discuss the suggestion that the mean weight in the population is 65 gm. Use $\alpha = 0.05$. [5]

13. Define chi-square distribution. From the following data can you conclude that there is association between the purchase of brand and geographical region? (Use 5% level of significance). [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

14. In a postal survey of 500 households, 330 said that they thought they were being overcharged for the public services within their area. [5]

i) Calculate an approximate 99% confidence interval for the population proportion, p, of households who thought they were being overcharged for public services within their area.

ii) Estimate the size of sample required to estimate the value of p to be within 99% confidence limits of ±0.025.

15. Following data gives the sample records of number of passenger take ticket at the counter of Bus during one hour period. [8]

22	58	32	36	62	57	25	45	23	37
64	56	46	60	29	49	63	36	26	58
60	26	58	58	29	43	53	36	45	22
52	43	45	31	45	39	35	38	30	60
58	42	54	62	52	42	65	58	51	60
53	45	31	53	22	53	51	52	47	59

Find the

i. Sample mean of Number of passenger
ii. Sample Standard deviation and Coefficient of variation.
iii. Standard error of the sample mean.
iv. Find the 95% and 99% confidence limit of sample mean

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: **- Probability and Statistic** *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. What is absolute and relative Measure of Dispersion? Construct a Box plot from the following data of marks of students as: [1+5]

Marks	10-20	20-30	30-40	40-50	50-60
No. of students	2	6	22	13	7

2. State the law of addition of probability. In a training, the 70% of persons achieved a rating of Satisfactory. Of those as rated as Satisfactory, 80% had Acceptable Scores on the personality test. Of those rated as Unsatisfactory, 35% had Acceptable Scores. Find the probability that an applicant would be a Satisfactory trainee given the Acceptable scores on personality test. [2+4]

3. Define Negative binomial distribution with its important characteristics. [5]

4. A particularly long traffic light on your morning commute is green 20% of the time that you approach it. Assume that each morning represents as independent trial. [5]

   i) Over five mornings, what is the probability that the light is green on exactly one day?
   ii) Over 20 mornings, what is the probability that the light is green on exactly four days?

5. The distribution function for a random variable X is [5]

   $F(x) = 1 - e^{-2x}$ for $x \geq 0$
   $= 0$ for $x < 0$

   i) Find $P(X > 2)$
   ii) Find mean and variance of the variable X.

6. Define Standard Normal Distribution with their respective probability density function and describe its properties. [5]

7. An article in Wear (Vol.152, 1992, pp.171-181) presents data on the fretting wear of mild steel and oil viscosity. Representative data follow, with x = oil viscosity and y = wear volume (10^{-4} cubic millimeters). [5]

y	240	181	193	155	172	110	113	75	94
x	1.6	9.4	15.5	20.0	22.0	35.5	43.0	40.5	33.0

   i) Fit the simple linear regression model using least
   ii) Predict fretting wear when viscosity x = 30

8. What are the two regression coefficients and what do they represent? Write the properties of regression coefficient. [5]

9. Define Central Limit Theorem. An electronics company manufactures resistors that have a mean resistance of 100 ohms and a standard deviation of 10 ohms. The distribution of resistance is normal. Find the probability that a random sample of 25 resistors will have an average resistance less than 95 ohms. [5]

10. Define standard error of sample mean. A population consist of the four numbers 12, 19, 13, 16. [5]

i) Write down all possible sample size of two without replacement.
ii) Find standard error of the sample mean.

11. Describe the procedure of the test of significance for difference of two population mean – for large sample. [5]

12. In the investigation of a citizens' committee complaint about the availability of fire protection within the country, the distance in miles to the nearest fire station was measured for each of five randomly selected residences in each of four areas. [5]

Area 1	7	5	5	6	8
Area 2	1	4	3	4	5
Area 3	7	9	8	7	8
Area 4	4	6	3	7	5

Do these data provide sufficient evidence to indicate a difference in mean distance for the four areas at the = 0.05 level of significance?

OR

The diameter of steel rods manufactured on two different extrusion machines is being investigated. Two random samples of sizes $n_1 = 15$ and $n_2 = 17$ are selected, and the sample means and sample variances are $\bar{x}_1 = 8.73, s_1^2 = 0.35, \bar{x}_2 = 8.68$, and $s_2^2 = 0.40$, respectively. Assume that $\sigma_1^2 = \sigma_2^2$ and that the data are drawn from a normal distribution. Is there evidence to support the claim that the two machines produce rods with different mean diameters? Use $\alpha = 0.05$ in arriving at this conclusion.

13. A random sample of 500 adult residents of Maricopa County found that 385 were in favor of increasing the highway speed limit to 75 mph, while another sample of 400 adult residents of Pima County found that 267 were in favor of the increased speed limit. Construct 95% confidence interval on the difference in the two proportions. [5]

14. Define chi-square distribution. From the following data can you conclude that there is association between the purchase of brand and geographical region? [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

Use 5% level of significance.

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic. [8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

i) Find sample mean, sample variance and sample standard deviation.
ii) Compute a value that measures the amount of variability relative to the value of mean.

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BCT – III / I Original

22 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistic *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Two different sections of a statistics class take the same quiz and the scores are recorded below: [6]

   a) Find the range and standard deviation for each section
   b) What do the range values lead you to conclude about the variation in the two sections?
   c) Why is the range misleading in this case?
   d) What do the standard deviation values lead you to conclude about the variation in two sections?

Section 1	1	20	20	20	20	20	20	20	20	20	20
Section 2	2	3	4	5	6	14	15	16	17	18	19

2. Define dependent and independent events with suitable examples. The independent probabilities that the three sections of a costing department will encounter a computer error are 0.2, 0.3 and 0.1 per week respectively. What is the probability that there would be: [6]

   i) At least one computer error per week
   ii) One and only one computer error per week

3. Write the differences and similarities between Binominal and Negative Binominal Distribution. [2+3]

4. A quality control engineer inspects a random sample of 4 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects. What are the probabilities that the inspector's sample will contain: [5]

   i) None of the batteries with defect?
   ii) At least two of the batteries with defects?
   iii) At most three of the batteries with defect?

5. A random variable X has the following probability density function as: [5]

$$f(x) = \begin{cases} kx^3(4-x)^2, 0 < x < 1 \\ 0, \text{otherwise} \end{cases}$$

   Find the value of k, using this value of k find mean and variance of distribution.

6. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be: [5]

   i) Between 39 and 42 volts
   ii) Less than 44 volts
   iii) More than 43 volts

OR

The daily consumption of electric power in a certain city follow a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the power plant of this city has daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day?

7. State central limit theorem. An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with mean equal to 800 hours and standard deviation of 4 hours. Find the probability that a random sample of 16 bulbs will have an average life of less than 12775 hours. [5]

8. What do you mean by sampling distribution of a sample mean and its standard Error? What would be the variance of sampling distribution of mean if sample is taken from finite population? [3+1]

9. Define partial and multiple correlation with suitable examples. Write down the properties of partial and multiple correlation. [5]

10. The following data gives the number of twists required to break a certain kind of forged alloy bar and percentage of alloying element A present in the metal. [5]

Number of twists	41	49	69	65	40	50	58	57	31	36
Percentage of element A	10	12	14	15	13	12	13	14	13	12

i) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twists required to break an alloy when percentage of element is 20.

ii) Find 99% confidence interval for the regression coefficient (i.e.slope)

11. In a certain factory, there are two independent processes manufacturing the same item. The average weight in a sample of 250 items produced from one process is found to be 120 gram with a standard deviation of 12 gram, while the corresponding figures in a sample of 400 items from the other process are 124 and 14 respectively. Test whether the two mean weights differ significantly or not at 5 percent level of significance. [5]

12. Three trained operators work on production of new product. The productivity of the operators are recorded as below: [5]

Operators	Production			
1	10	12	14	16
2	12	11	13	16
3	14	15	12	11

Using ANOVA test whether the difference in average productivity due to the difference in operators are significant. Use $\alpha = 5\%$.

OR

Define confidence level and significance level. A company claims that its light bulbs are superior to those of its main competitor. If a study showed that a sample of 40 of its bulbs has mean lifetime of 647 hours of continuous use with standard deviation of 27 hour. While a sample of 40 bulbs made by its main competitor had mean lifetime of 638 hours of continuous use with standard deviation of 31 hours. Does this substantiate claim at 1% level of significance?

13. Write down the steps for testing hypothesis on difference between two population proportions for the large sample size. [5]

14. 1072 students were classified according to their intelligence and economic conditions. Test whether there is any association between intelligence and economic condition. [6]

Economic Condition	Intelligence			
	Excellent	Good	Mediocre	Dull
Good	48	199	181	82
Not good	81	185	190	106

15. The sample of length of life of bulbs from two companies are given below: [8]

Length of life (hours)	Company	
	A	B
500-600	10	3
600-700	21	8
700-800	6	15
800-900	8	12
900-1000	21	4
1000-1100	10	5
1100-1200	2	15
1200-1300	12	13
1300-1400	19	7
1400-1500	9	7
1500-1600	3	4
1600-1700	7	6
1700-1800	5	3
1800-1900	4	2
1900-2000	1	3

i) Calculate mean length of life of bulbs for company A and company B.
ii) Calculate sample standard deviation and sample variance for given data.
iii) Which company's bulbs are more uniform?

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23 TRIBHUVAN UNIVERSITY	Exam.	New Back (2066 & Later Batch)		
INSTITUTE OF ENGINEERING	Level	BE	Full Marks	80
Examination Control Division	Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
2071 Shawan	Year / Part	III / I	Time	3 hrs.

Subject: -Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Write difference between measure of central tendency and measure of dispersion and their importance. The following table represents the marks of 100 students. [6]

Marks	0-20	20-40	40-60	60-80	80-100
No. of Students	14	?	27	?	15

If the mode value is 58, find the missing frequencies and the mean of all 100 students.

2. Define multiplication law of probability for dependent and independent events with suitable examples. The independent probabilities that the three sections of a costing department will encounter a computer error 0.2, 0.3 and 0.1 per week respectively. What is the probability that there would be: [6]
   i) At least one computer error per week?
   ii) One and only one computer error per week?

3. Define Negative binomial distribution with an example. How does the negative binomial distribution differ from binomial distribution? [2+3]

4. A heavy machinery manufacturer has 3840 large generators in the field that are under warranty. If the probability is 1/1200 that any one will fail during the given year, find the probability: [5]
   i) That exactly 3 generators will fail during the given year?
   ii) That between 2 and 6 are fail during the given year?

5. Define the standard normal distribution. Give the condition for normal approximation of Poisson distribution. [2+3]

6. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be: [5]
   i) Between 39 and 42 volts
   ii) Between 40 and 43 volts
   iii) Less than 44 volts

   OR

   A probability density function is given by $f(x)=Ax(6-x)^2$ for $0 < x < 6$
   i) Find the value of A
   ii) Find the mean and variance of this distribution

7. Define sampling distribution of proportion with example. [4]

8. The monthly income of a particular group of retailer's follows a normal distribution with mean Rs.21,000.00 and standard deviation of Rs.9,487.00. A random sample of size 10 retailers was taken and the mean income is calculated. Find the probability that this sample lies between Rs.18,000.00 and Rs.27,000.00. [6]

9. Define partial correlation and multiple correlations with suitable examples. Write down properties of partial and multiple correlations. [5]

10. The following data gives the number of twists required to break a certain kind of forced alloy bar and percentage of alloying element A present in the metal. [5]

Number of twists	41	49	69	65	40	50	58	57	31	36
Percentage of element A	10	12	14	15	13	12	13	14	13	12

   i) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twist required to break an alloy when percentage of element is 20.

80
32
3 hrs.

11. The mean weight loss of n = 16 grinding balls after a certain length of time in mill slurry is 3.42 grams with a standard deviation of 0.68 gram. Construct a 99% confidence interval for the true mean weight loss of such grinding balls under the stated conditions. [4]

12. Four trained operators works on production of new product. The productivity of the operators are recorded as below: [6]

Operators	Production			
1	10	12	14	16
2	12	11	13	16
3	14	15	12	11
4	16	10	17	17

Using ANOVA, test whether the difference in average productivity due to the difference in operators are significant. Use $\alpha = 5\%$

OR

The following are the average weekly losses of worker hours due to accidents in 10 industrial plants before and after a certain safety program was put into operation:

Before	45	73	46	124	33	57	83	34	26	17
After	36	60	44	119	35	51	77	29	24	11

Use the 0.05 level of significance to test whether the safety program is effective.

13. Define confidence level and significance level. A manufacturer claimed that at least 95% of the cables supplied to the ABC Company confirmed to specifications. However, the production manager at ABC Company wasn't satisfied with the claim of the manufacturer. Hence, to test the claim, the manager examined a sample of 250 cables supplied last month and found that 228 cables as per the specifications. Can you conclude that the production manager is right to doubt on the claim of the manufacturer? (α=0.01) [5]

14. Define chi-square distribution. A book containing 500 pages was thoroughly checked. The distribution of number of error page was given below as: [5]

Number of errors	0	1	2	3	4	5
Number of pages	275	138	75	7	4	1

Using chi-square test of goodness of fit, verify whether the arrivals follow a Poisson distribution at 5% level of significance.

15. The sample of length of life of bulbs from two companies are given below: [8]

Length of Life (hours)	Company	
	A	B
500-600	10	3
600-700	21	8
700-800	6	15
800-900	8	12
900-1000	21	4
1000-1100	10	5
1100-1200	2	15
1200-1300	12	13
1300-1400	19	7
1400-1500	9	7
1500-1600	3	4
1600-1700	7	6
1700-1800	5	3
1800-1900	4	2
1900-2000	1	3

i) Calculate mean length of life of bulbs for Company A and Company B.
ii) Calculate sample standard deviation and sample variance for given data.
iii) Which Company's bulbs are more uniform?

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Calculate the standard deviation from the following data regarding marks obtained by students in a test: [3+3]

Marks:	1	2	3	4	5	6	7	8	9
No. of Students	32	41	57	98	123	83	46	17	3

What will be the value of standard deviation if the marks obtained by each of the students are increased by one?

2. State Baye's theorem. A manufacturer of air-conditioning units purchases 70% of its thermostats from company A, 20% from company B and the rest from company C. Past experience shows that 0.5% of company A's thermostats, 1% of company B's thermostats and 1.5% of company C's thermostats are likely to be defective. An air-conditioning unit randomly selected from this manufacturer's production line was found to have a defective thermostat. Find the probability that company A supplied the defective thermostat. [2+4]

3. Write the differences and similarities between Binomial probability Distribution and Negative Binomial Probability distribution. [2+3]

4. The number of accident in a year attributes to taxi drivers in a city follows Poisson distribution with mean 3. Out of 1000 taxi driver, find the approximately the number of driver with: [5]
   i) No accidents in a year
   ii) More than 3 accident in a year

5. Define normal distribution. Give the condition for normal approximation of Binomial distribution and Poisson distribution. [6]

6. The time required to assemble a piece of machinery is a random variable having approximately a normal distribution with mean 12.9 minutes and standard deviation of 2 minutes. What are the probabilities that the assembly of a piece of machinery of this kind will take (a) at least 11.5 minutes (b) between 11.0 to 14.8 minutes? [4]

OR

The probability density function given by

$f(x) = cx^2, 0 < x < 3$
0, Otherwise

i) Find the value constant C?
ii) Compute $P(1<x<2)$
iii) Find the distribution function

7. What do mean by central limit theorem? Write its applications. [4]

8. The lifetime of a certain brand of an electric bulb may be considered a random variable with mean 1200 hours and standard deviation 150 hours. Using central limit theorem, find the probability that the sample mean of the lifetime with a sample of size 36, is between 1100 hours and 1300 hours. [2+4]

9. Define partial correlation and multiple correlations with suitable examples. Write two properties of each. [6]

10. Observation on the yield of a chemical reaction taken at various temperatures was recorded as follows: [4]

X (°C)	150	150	200	250	250	300	150
Y%	75.4	81.2	85.5	89	90.5	96.7	75.4

Fit a simple linear regression and estimate value of yield at 200°C.

11. An analysis for pH (acidity) in an random sample of water from 40 rainfalls showed that mean is 6.7 and s.d. is 0.5. Find a 99% confidence interval for the mean pH in rainfalls. [4]

12. As a part of investigation of the collapse of the roof of a building, a testing laboratory is given all the available bolts that connected the steel structure at three different positions on the roof. The forces required to shear each of these bolts (coded values) are as follows: [6]

Position 1	90, 82, 79, 98, 83, 91
Position 2	105, 89, 93, 104, 89, 95, 86
Position 3	83, 89, 80, 94

Perform an ANOVA to test at the 0.05 level of significance whether the difference among the sample means at the three positions are significant.

OR

The following are the average weekly losses of worker-hours due to accidents in 10 industrial plants before and after a certain safety program was put into operation:

45 and 36, 73 and 60, 46 and 44, 124 and 119, 33 and 35, 57 and 51, 83 and 77, 34 and 29, 26 and 24, 17 and 11. Use the 0.05 level of significance to test whether the safety program is effective.

13. The results of polls conducted two weeks and four weeks before an election are shown in the following table: [5]

	Two weeks before election	Four weeks before election
For republican candidate	79	91
For democratic candidate	84	66
Undecided	37	43

Use the 0.05 level of significance to test whether there has been change in opinion during the 2 weeks between the polls.

14. A manufacturer of submersible pumps claims that at most 30% of the pumps require within the first 5 years of operation. If a random sample of 120 of these pumps includes 47 which required repairs within the first 5 years, test the null hypothesis $p = 0.30$ against the alternative hypothesis $P > 0.30$ at the 0.05 level of significance. [5]

15. The following data are the ages (in months) at which $n = 50$ children were first enrolled in a preschool. [8]

38	40	30	35	39
47	35	34	43	41
32	34	41	30	46
55	39	33	32	32
42	50	37	39	33
40	48	36	31	36
36	41	43	48	40
35	40	30	46	37
45	42	41	36	50
45	38	46	36	31

a) Find sample mean, sample variance and sample standard deviation

b) Compute a value that measures the amount of variability relative to the value of mean

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23 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. In statistics paper five candidates obtain the marks as 33, 38, 48, 59 and 72. Calculate the mean and standard deviation of these marks. If 10 marks are added for each student, what will be mean and standard deviation? [3+3]

2. Distinguish between mutually exclusive and equally likely events with examples. What is the use of Bayes theorem in theory of probability? In a college 45% students belong to Civil, 30% Electronics and remaining to other faculties. The probability of being top is 5%, 4% and 2% respectively in civil, electronics and others. If this year's result is published, what is the probability that the topper is form electronics? [6]

3. Define poisson probability Distribution. Write the conditions for poisson approximation to Binomial Distribution. [2+3]

4. A quality control engineers inspects a random sample of 3 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects, what is the probabilities that the inspector's sample will contain. [5]

   i) None of the batteries with defect?
   ii) Only one of the batteries with defect?
   iii) At least two of the batteries with defect?

5. Define standard normal distribution with area property. [6]

6. The marks obtained by IOE students in statistics are 50 on average with variance 16. If 5000 students have given the exam, find the following: [4]

   a) The number of students securing marks less than 40?
   b) The number of students securing marks between 35 to 60?

   OR

   Let X denotes the amount of time for which a book on two-hour reserve at a college library is checked out by a randomly selected students, and suppose that X has density function $f(x) = kx, 0 \le x \le 2$
   0, otherwise

   a) Find the value of k
   b) Calculate $P(X \le 1)$
   c) Calculate $P(0.5 \le X \le 1.5)$
   d) Calculate $P(1.5 < X)$

7. Define sampling distribution of mean. [4]

8. Define Central Limit Theorem. In a sample of 16 observations from a normal distribution with mean of 150 and a variance of 256, what is (a) $P(\bar{x} < 160)$ (b) $P(\bar{x} > 142)$ [2+4]

9. What is the difference between correlation and regression? Plot the sample regression line of Y on X. [2+4]

Speed x	30	40	50	60	70
Stopping distance y	160	240	330	435	500

10. What do you mean by correlation coefficient? Show that correlation coefficient lies between -1 and +1. [4]

11. Describe the procedure of the test of significance of difference between two means for large sample. [4]

12. Set up an ANOVA table for the following acre production of data for three varieties of wheat each growth on 4 plots and state if the variety differences are significant. Use $\alpha = 0.05$ [6]

Plot of land	Variety of wheat		
1	6	5	5
2	7	5	4
3	3	3	3
4	8	7	4

OR

The following random samples are measurement of the heat producing capacity (in millions of calories per ton) of specimens of coal from two mines:

Mine 1	8260	8130	8350	8070	8340	-
Mine 2	7950	7890	7900	8140	7920	7840

Use the 0.01 level of significance to test whether the difference between means of these two samples is significant.

13. What do you mean by chi square distribution? The following test gives the information for the engineering students interest with ability in computer. Is there any significant relationship between interest in engineering and ability in computer? [5]

	Interest in Engineering	Low	Average	High
Ability in computer	Low	6	12	32
	Average	33	61	18

14. Two different types of injection-molding machines are used to from plastic parts. A part is considered defective if it has excessive shrinkage or is discolored. Two random samples, each of size 300, are selected and 15 defective parts are found in the sample from machine 1 while 8 defective parts are found in the sample from machine 2. Is it reasonable to conclude that both machines produce the same fraction of defective parts, using $\alpha = 0.05$? [5]

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic. [8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

a) Find sample mean, sample variance and sample standard deviation

b) Compute a value that measures the amount of variability relative to the value of mean

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23 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, B.Agri.	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. The following are data on the breaking strength (in pounds) of 3 kinds of material: [2×3]

Material 1	144	181	200	187	169	171
Material 2	186	194	176	182	133	183
Material 3	197	165	180	198	175	164

   i) Calculate the average breaking strength and the median breaking strength for each material.

   ii) Calculate standard deviation and variance for each material.

2. Define independent and mutually exclusive events with an example. An assembly plant receives its voltage regulators from these three different suppliers, 60% from supplier A, 30% from supplier B and 10% from supplier C. It is also known that 95% of voltage regulators from A, 80% of these from B and 65% these from C perform according to specifications. What is the probability that: [2×3]

   i) Anyone voltage regulator received by the plant will perform according to specifications.

   ii) A voltage regulator that perform according to specification came from B and C.

3. Write difference between binominal distribution and negative binomial distribution with suitable examples. [2+2]

4. Among the 12 solar collectors on display at a trade show, 9 are flat-plate collectors and the others are concentrating collectors. If a person visiting the show randomly selects 6 of the solar collectors to check out, what is the probability that [2+2+2]

   i) Non of them will be flat-plate collectors.

   ii) At least 3 of them will be flat-plate collectors.

   iii) At most 2 of them will be concentrating collectors.

5. Define standard normal distribution. Write down its importance in engineering field. [4]

6. The breakdown voltage X of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and standard deviation 1.5 volts. What is the probability that the breakdown voltage will be [6]

   i) Between 39 and 42 volts

   ii) At most 43 volts

   iii) At least 3.9 volts

OR

   If a random variable X has a function

   $f(x) = 2e^{-2x}$ for $x > 0$

   0 for $x \le 0$

   Find (i) Verify that the function is probability density function

   (ii) $P(1 < x < 3)$

   (iii) Find mean and variance

7. What do you mean by the sampling distribution of sample proportion? [4]

8. A population consists of 5,6,9,12. Consider all possible samples of size two which can be drawn without replacement from this population. Find [2×3]

i) Population mean and population standard deviation.
ii) Mean of sampling distribution of mean.
iii) Standard error of sampling distribution of mean.

9. The simple correlation coefficient between fertilizer (X_1), seeds (X_2) and productivity (X_3) are r_{12}=0.69, r_{13}=0.64 and r_{23}=0.85. Calculate the partial correlation $r_{12.3}$ and multiple correlations $R_{1.23}$. [4]

10. An article in Concrete Research presented data on compressive strength X and intrinsic permeability Y of various concrete mixes and cures. Summary quantities are n = 14, $\Sigma y = 572$, $\Sigma y^2 = 23{,}530$, $\Sigma x = 43$, $\Sigma x^2 = 157.42$ and $\Sigma xy = 1697.80$. Assume that the two variables are related according to the simple linear regression model. [6]

i) Calculate the least squares estimates of the slope and intercept
ii) Use the equation of the fitted line to predict what permeability would be observed when the compressive strength is x = 4.3.

11. The following are the breaking strength of three different brands of cables. [6]

Brand	Breaking strength					
A	40	30	50	60	30	-
B	60	40	55	65	-	-
C	60	50	70	65	75	40

Construction ANOVA table and test for the equality of the average breaking strength of cables at α=5%

OR

In a manufacturing company the new modern manager is in a belief that music enhances the productivity of workers. He made observations on 6 workers for a week and recorded the production before and after the music was installed. From the data given below, can you conclude that the productivity has indeed changed due to music? (α=1%)

Week without music	219	205	226	198	209	216
Week with music	235	186	240	203	221	205

12. A random sample of size 16 showed a mean of 52 with a standard deviation 4. Obtain 99% and 95% confidence limits population mean. [4]

13. From the following data can you conclude that there association between the purchase of brand and geographical region using Chi-square test at α=1%? [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

14. What are the steps in hypothesis testing? A study shows that 16 of 200 computers produced on one assembly need readjustment before shipping while same happens on 14 out of 300 produced. Test at 1% level of significance that the second assembly is superior than first one? [5]

15. Entrance scores of three engineering institutes is as follows: [1+2+2+3]

Institutes									
A	740	800	830	840	860	890	830	930	1070
B	655	775	825	978	989	1025	950	980	1100
C	850	825	749	870	565	978	925	950	1000

Calculate mean, standard deviation, coefficient of variation and answer the following

i) Which institute is good?
ii) Which institute is consistent/reliable?

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Control System *(EE 504)*

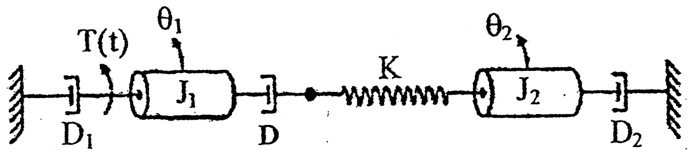
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Define control system. Draw the block diagram of closed loop control system and explain the role of each block briefly. [1+4]

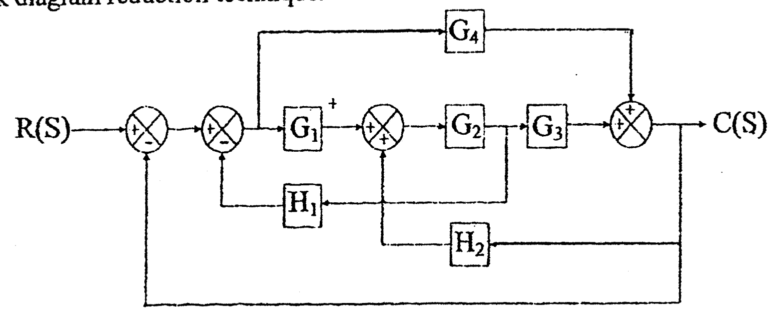
   b) Why closed loop system is faster than open loop control system? Explain. [3]

   c) What is derivative feedback controller? Draw block diagram and find the transfer function and hence show its effect on transient performance of the system. [6]

2. a) Find the transfer function, $\frac{\theta_2(S)}{T(S)}$, for the mechanical rotational system of figure below. Also draw the T-V and T-I analogy circuit of the system. [8]



   b) Determine the transfer function C(s) / R(s) of the block diagram given below, using block diagram reduction technique. [8]



3. a) Using R-H criteria, tell how many roots of polynomial is in right half s-plane, in left half s-plane and on jw axis. Comment on stability. [8]

   $S^5 + 4S^4 + 2S^3 + 8S^2 + S + 4 = 0$

   b) The open loop transfer function of a unity feedback system is given by:

   $$G(S)H(S) = \frac{K}{S(1+ST)}$$

   Where, K is gain constant and T is time constants. With the gain multiplied by a factor K_1 the maximum overshoot of the system is increased from 25% to 50%. Determine K_1. [6]

4. a) Sketch the root locus of unity feedback system with $G(s)=\frac{k(s-4)}{(s^2+6s+18)}$, hence find the range of parameter k for stability of the closed loop system. Does the system exhibit sustained oscillation for any value parameter k? [8]

b) The open loop transfer function of a system is $G(s)H(s)=\frac{1+4s}{s^2(1+s)(1+2s)}$.
Determine the stability of open and closed loop system using Nyquist Criterion. [8]

5. a) A system is characterized by the equation

$$\frac{Y(S)}{U(S)}=\frac{20(4s+2)}{s^3+5s^2+8s+2}$$

Find its state and output equation and express in matrix form. [8]

b) The forward path transfer function of unity feedback system is given by $G(s)=\frac{K}{s(s+10)(s+2)}$. Design a suitable location of pole zero pair for a lead compensating network so that phase margin is at least 50° and velocity error constant is maintained at least 800 sec^{-1}. [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Baishakh

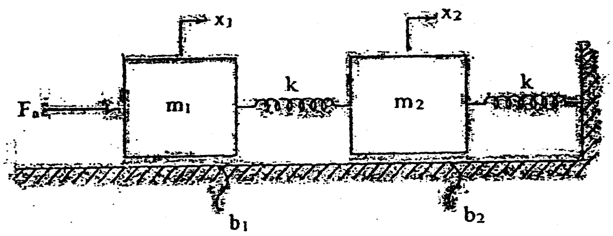
Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Control System (*EE 504*)

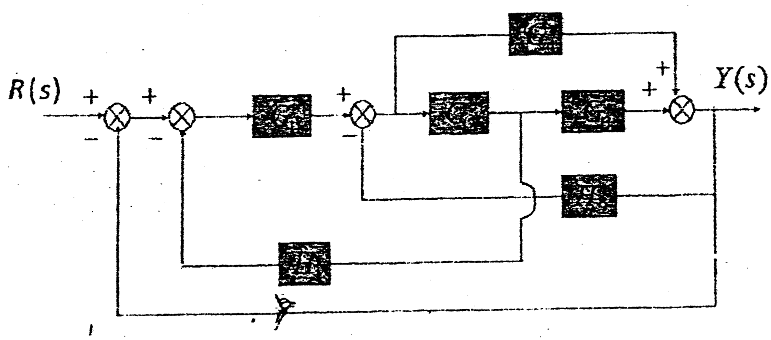
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt* ***All*** *questions.*
- ✓ *The figures in the margin indicate* ***Full Marks.***
- ✓ *Assume suitable data if necessary.*

1. Define control system with its importance. State an example of close and open loop system that you see in everyday life with block diagram. [4+4]

2. Find the transfer function of given mechanical system. Draw the analogous electrical circuit of the mechanical system given below. [2+6]



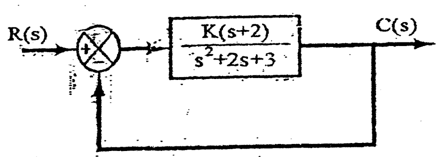
3. Determine the transfer function Y(s)/R(s) for the block diagram below by reduction method. [8]



4. Construction Routh array and determine the stability of the system whose characteristics equation is $s^6+2s^5+8s^4+12s^3+20s^2+16s+16$

   Comment on the location of the roots characteristics equation. [8]

5. Sketch the root locus of following system and determine the range of k for which the system will be stable. [6+2]



6. Find the Gain crossover frequency, phase crossover frequency, gain and phase margin using Bode plots for the following transfer function. [8]

$$G(s) = \frac{1000}{(1+0.1s)(1+0.001s)}$$

7. Sketch the polar plot of the given system. [8]

$$G(s) = \frac{20}{s(s+1)(s+2)}$$

8. For a second order system given by the transfer function. Find the: rise time, peak time, settling time and maximum overshoot. [8]

$$G(s) = \frac{25}{s^2+8s+25}$$

9. Write short notes on: [2×4]

   a) PID controllers in control system.
   b) Lead and Lag Compensators.

10. Discuss the advantages and limitations of state space analysis of control systems. Find the transfer function for the system represented by following state space model. [2+6]

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

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEI, BAS	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

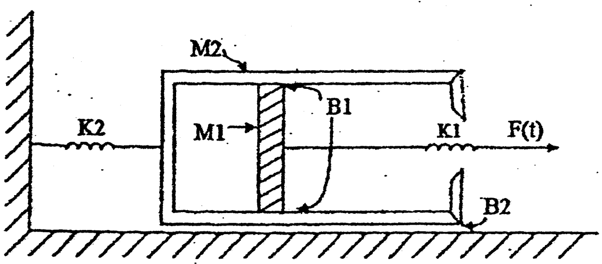
Subject: - Control System *(EE 504)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *__Semi log/ Graph paper will be provided.__*
- ✓ *Assume suitable data if necessary.*

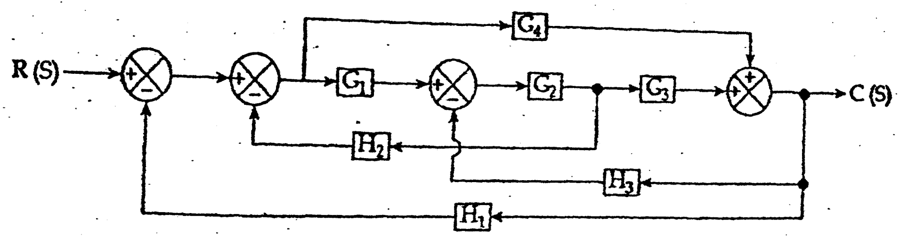
1. a) As a control engineer, you are required to control the actuator of a rotating system to get constant speed. Which type of control system will you suggest and why? [5]

   b) Discuss the effect of feedback on time constant of a control system. [3]

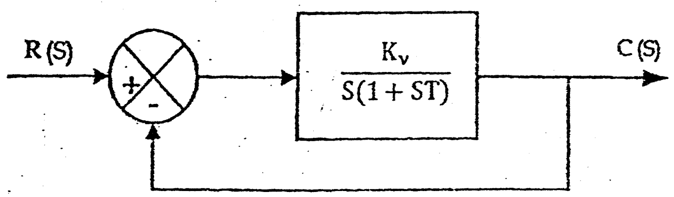
   c) Find Transfer function and develop F-V and F-I analogous circuits of the following figure. [8]



2. a) From the given block diagram, find the transfer ratio $\frac{C(S)}{R(S)}$ using block diagram reduction method. [8]



   b) A servomechanism as shown in block diagram below is designed to keep a radar antenna pointed at a flying aeroplane. If the aeroplane is flying with a velocity of 600 km/hr, at a range of 2 km and the maximum tracking error is to be within 0.1°, determine the required velocity error coefficient. [4]



   c) A system has 25% overshoot and settling time of 6 seconds, for a unit step input. Determine the transfer function and Calculate peak time. Assume e_{ss} as 2%. [4]

3. a) The characteristic equation of the system is $s^3 + 9s^2 + sK + K = 0$. Sketch the complete root locus and comment on stability. [8]

b) A system is described by the following equations:

$$x(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 2 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} x(t)$$

Find the transfer function of the system and identify if the system is stable. [8]

4. a) What is relative and absolute stability? Check the stability of system with characteristics equation: $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$ using R-H criteria. [2+6]

b) Using Nyquist criteria, determine the stability of the feedback system whose OLTF is given by: [8]

$$G(s).H(s) = \frac{1}{s^2(1+2s)(1+s)}$$

5. a) In response to unit ramp input, discuss role of derivative feedback controller for a second order system. [4]

b) The open loop transfer function of type-II system with unity feedback system is given by $G(S) = \frac{K}{S^2(1+0.25\,S)}$ Design a lead compensator to meet the following specifications.

(i) Acceleration error Constant $(K_a) = 10/\text{sec}^2$

(ii) PM at least 35° [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

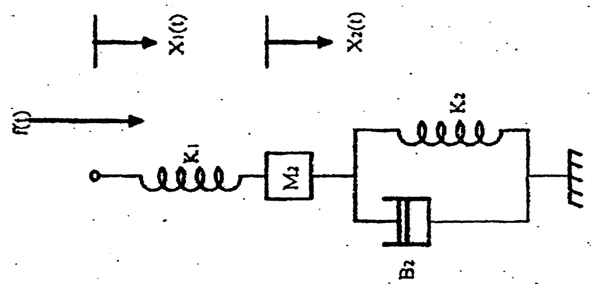
Subject: - Control System *(EE 504)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Semi log/ Graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

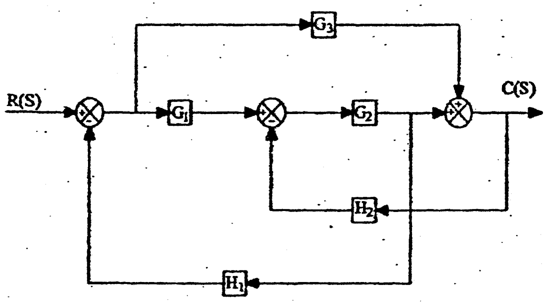
1. a) Stating an example of a system that you see in your field of study, explain what do you understand by closed loop system and its importance. [5]

   b) Why closed loop system is faster than open loop control system? Describe with necessary mathematical expressions. [3]

   c) Find transfer function for the system as in figure. Also develop F-V and F-I analogy circuits. [4+2+2]



2. a) Find overall transfer function of the following diagram using block diagram reduction technique. [8]



   b) The system below in figure (a) when subjected to unit step input; the output response is as shown in the figure (b). Determine the value of K and T. [8]

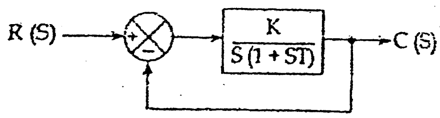


Figure: (a)

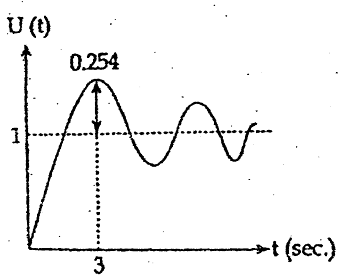
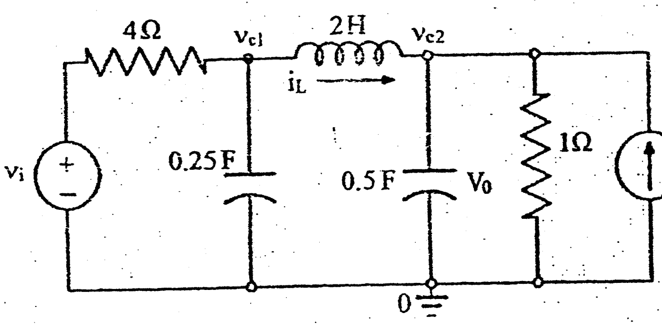


Figure: (b)

3. a) For a unity feedback system the OLTF of a control system is given by $G(S) = \frac{K}{S(S+4)(S^2+4S+20)}$; Sketch the root locus for $0 \leq K \leq \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

b) Find state space representation of the system. [6]



4. a) The characteristics equation of a feedback control system is [8]

$$S^4 + 20S^3 + 15S^2 + 2S + K = 0$$

(i) Determine the range of K for the system to be stable.

(ii) Can the system be marginally stable? If so, find the required value of K and the frequency of sustained oscillation.

b) Sketch polar plot, determine Gain Margin, phase margin and comment on stability for a unity feedback system with feed forward transfer function $G(S) = \frac{10}{S(S+1)^2}$. [8]

5. a) There exists a permanent mismatch actually to track the reference by the actual system. Suggest a wayout to follow your system as per reference and justify. [4]

b) Design a suitable phase lag compensating network for $G(S) = \frac{K}{S(1+0.1S)(1+0.2S)}$ to meet the following specifications: $K_v = 30\ \text{sec}^{-1}$ P.M $\geq 40°$ [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BAM, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

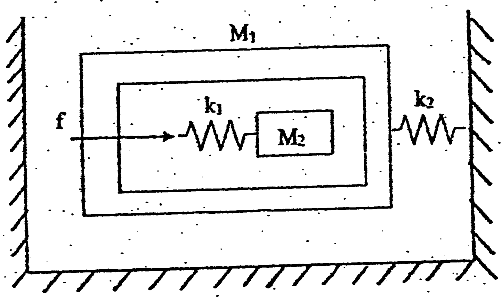
Subject: - Control System *(EE 602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

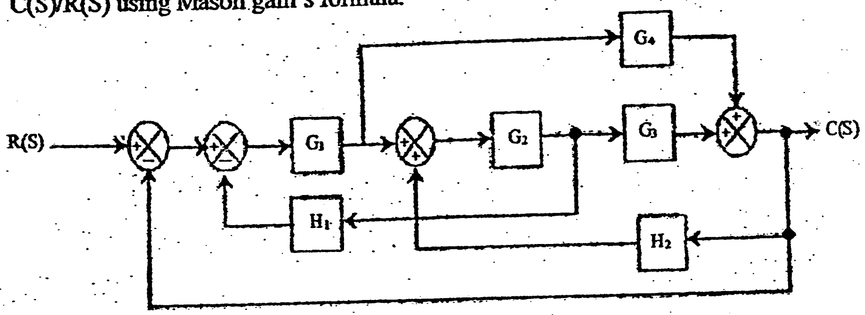
1. a) Why do you think traffic light system in Kathmandu is an open loop control system? [4]

   b) What is the affect of feedback on system gain and speed of response and how? [4]

   c) Consider displacement of mass M_2 as output and find transfer function of the mechanical system as in figure. Also find F – I analogous circuit. [6+2]



2. a) From the given block diagram, draw the signal flow graph and find the transfer ratio C(S)/R(S) using Mason gain's formula. [8]



   b) For the system as in figure (a), the unit step response is as in figure (b), determine M, B and K. [8]

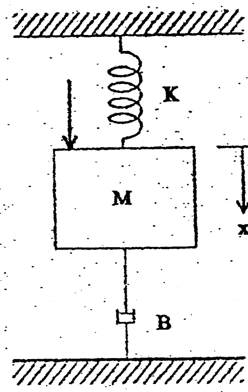


Fig (a)

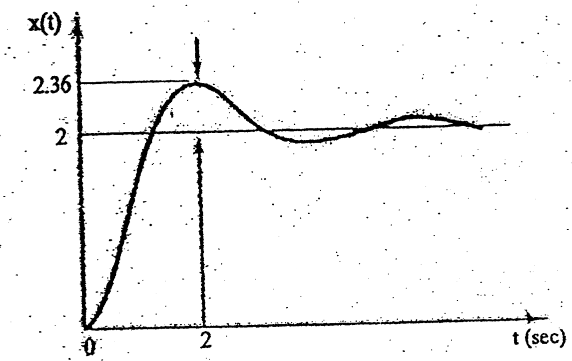
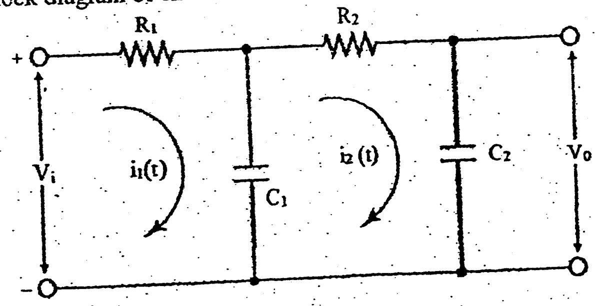


Fig (b)

3. a) Draw the block diagram of circuit shown below: [4]



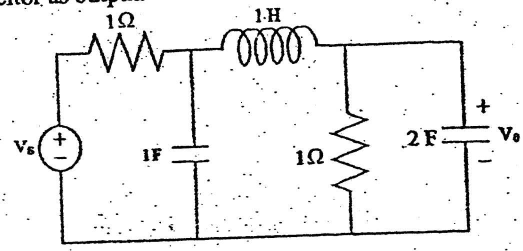
b) The characteristic equation of a feedback control system is given by, [4]

$$s^4 + 20s^3 + 15s^2 + 2s + K = 0$$

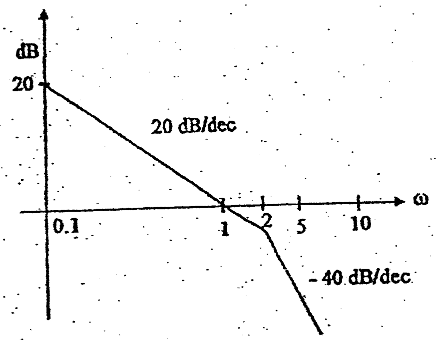
(i) Determine the range of K for the system to be stable.
(ii) What value of K will make the system marginally stable? Also, find the frequency of sustained oscillation.

c) Draw the root locus for the system with open loop transfer function as $G(S)H(S) = \dfrac{K}{s(s^2+10s+24)}$ and hence from the root locus, find the gain(k) and corresponding natural frequency of oscillation when the damping ration is 0.7. [8]

4. a) Write the state space equation for the electrical network shown below. Take voltage across 2F capacitor as output. [5]



b) Find the open loop transfer function with the help of following Bode plot. [3]



c) For open loop transfer with unity feedback $G(S) = \dfrac{s+2}{(s+1)(s-1)}$. Sketch Nyquist plot, determine gain margin and comment on stability. [8]

5. a) What kind of controller would you recommend to bring changes in transient properties of a system and how? [4]

b) The open loop transfer function of a unity feedback control system is given by $G(s) = \dfrac{K}{S(1+0.2s)}$. Design a lead compensator such that the velocity error constant, $K_v = 10\ sec^{-1}$ and phase margin = 50°. Also draw the bode diagram for compensated system. [12]

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

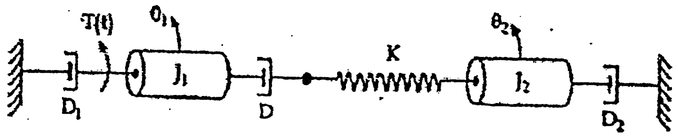
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Control System *(EE 504)*

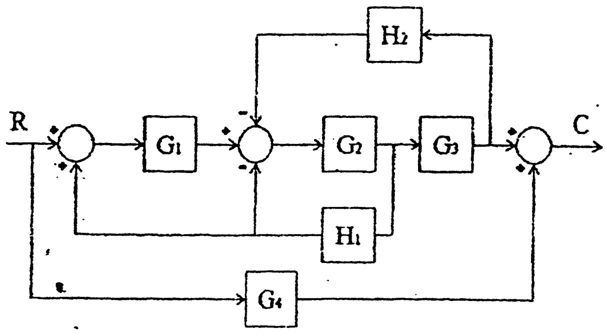
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? "When feedback is added on a control system, it's response is faster." Illustrate this statement mathematically. [2+6]

   b) Find the transfer function, $\frac{\theta 2(S)}{T(S)}$, for the mechanical rotational system of figure below. Also draw the T-V and T-I analogy circuit of the system. [8]



2. a) Determine the transfer function C/R for the block diagram below by signal flow graph (SGF) techniques. [8]



   b) The open loop TF a unity feedback control system is given as

$$G(S) = \frac{k}{s(s^2+s+1)(s+2)+k}$$

   Determine the range of gain k for the system to be stable. Also determine the value of k which will cause the sustained oscillation and corresponding oscillation frequency. [5+3]

3. a) The open loop transfer function of a control system is given by

$$G(S)H(S) = \frac{k}{s(s+4)(s^2+4s+20)}$$

   Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

   b) Write short notes on followings: [3+3]

   (i) Characteristics of PI and PD control actions
   (ii) Nyquist stability criterion

4. a) Sketch the polar plot of the system whose open loop transfer function is given by

$$G(S)H(S)=\frac{1}{s(1+s)(1+2s)}$$. Also comment on stability. [8]

b) Discuss the advantages and limitations of state space analysis of control systems. Find the transfer function for the system represented by following state space model. [2+6]

$$x=\begin{bmatrix}-3 & 1\\ -2 & 0\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$y=\begin{bmatrix}1 & 0\end{bmatrix}x$$

5. Design a suitable lead compensating network for $G(S)=\frac{k}{s^2(1+0.25s)}$ to meet the following specification [16]

$K_a=10\ sec^{-1}$

P.M $\geq 35°$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

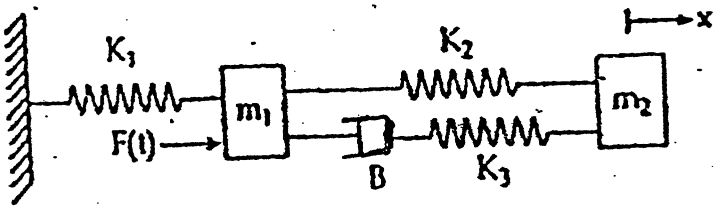
Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BAM, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE 602)*

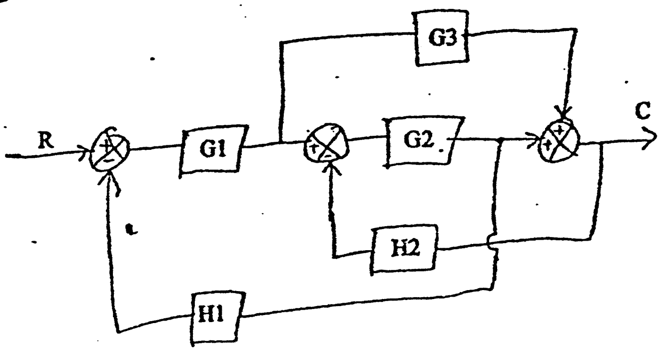
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Semilog graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? Draw the block diagram of a closed loop control system and briefly explain the function of each block. [6]

   b) Find the transfer function $\frac{X(S)}{F(S)}$, for the mechanical system of figure below. Also draw the F-V and F-I analogy circuit of the sy stem. [10]



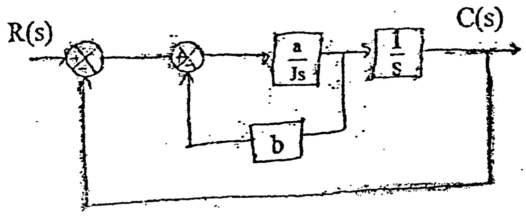
2. a) Develop Signal Flow graph for the block diagram model below and find transfer function using Mason's gain formula. [2+6]



   b) Check stability for the system with open loop transfer function $G(S)H(S)=\frac{2}{2s^5+3s^4+2s^3+s^2+2s}$ using R-H criterion. [4]

   c) What is derivative controller? How and why it can be useful? [4]

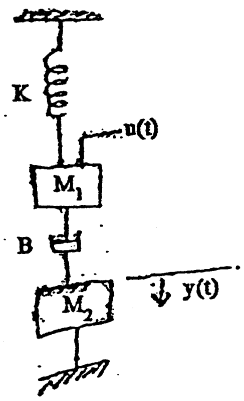
3. a) Determine values of a and b of the closed loop control system shown below, so that maximum overshoot for unit step input is 25% and the peak time is 2 sec. Assume that J=1 kg/m^3. [6]



b) Sketch Root locus plot for the system open loop transfer function $G(s)H(s) = \frac{k(s+2)}{s((s+1)(s^2+8s+64))}$. Discuss the region for stability, unstability and marginal stability. What is frequency of oscillation at the point of marginal stability? [10]

4. a) the open loop transfer function of closed loop system is $G(s)=\frac{2}{s(s+1)(2s+1)}$. Using Niquist Criterion, determine closed loop stability of this system. [8]

b) Consider a mechanical system shown in figure below. The external force u(t) is input to the system and displacement y(t) of the mass is the output. Obtain the state space representation of the system. [8]



5. Why lead compensator is required? Design a suitable lead compensating network for $G(S) = \frac{k}{s^2(1+0.25s)}$ to meet the following specification $K_a=10\ sec^{-1}$ $P.M \geq 35°$. [2+14]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

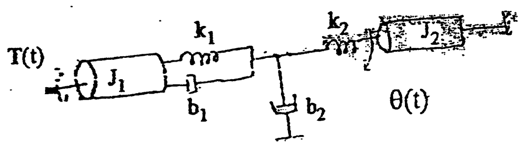
Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BAM, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE 602)*

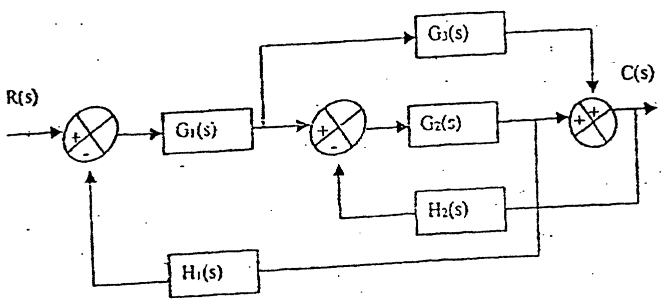
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Semilog graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. a) Which of the system is more sensitive to the disturbance and prove it how? Also discuss effect of gain on response of the system. [4+4]

   b) Find the transfer function $\frac{\theta(s)}{T(s)}$ for the mechanical system rotational system shown below: Also develop T-I analysis circuit. [8]



2. a) Using block diagram reduction technique, find the tr. Function $\frac{C(S)}{R(S)}$ of the figure given below. [8]



   b) A system has 40% overshoot and requires a settling time of 4 seconds when given a step input. Find peak time and rise time. [8]

3. a) Using R-H criteria fin the range of K for system having characteristics equation shown below, to be stable. [6]

$$S^4+2S^3+(4+K)S^2+9S+25=0$$

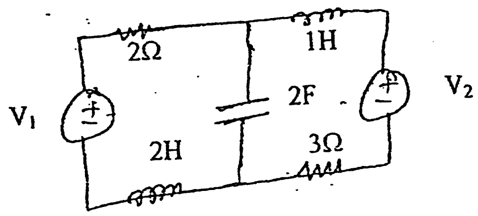
   b) Sketch Rout locus plot for the system with open loop transfer function. [6]

$$G(s)H(s)=\frac{k(s-1)}{s(s-1)}$$

   c) What sort of measures would you apply to track a reference from the actual output of the system? [4]

4. a) Using Nyquist criterion determine the stability of the feedback system whose open loop transfer function is given by $G(s)\,H(s)=\dfrac{1}{s(1+2s)(1+s)}$ and what is its gain margin? [10]

b) Develop state space model for circuit below. [6]



5. a) Consider a system shown below. The open loop transfer function is given by: $G(s)H(s)=\dfrac{2}{s(s+1)(s+2)}$. It is desired to compensate the system, so that the static velocity error constant K_v is 5 per second. The phase margin is at least 40° and gain margin is at least 10dB. Determine transfer function of appropriate lag compensator. [12]

b) Consider a point P in s-plane which actually indicate dominant closed loop pole of the system. How would you recognize that the root locus passes through the point P? [4]

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11 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BAME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

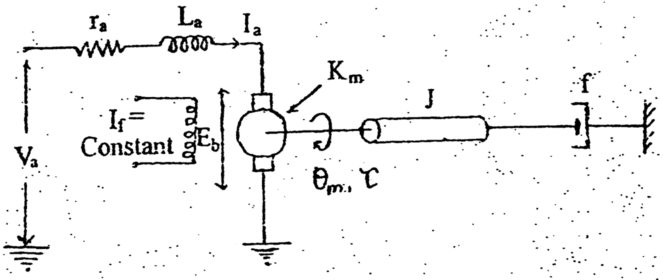
Subject: - Control System *(EE602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

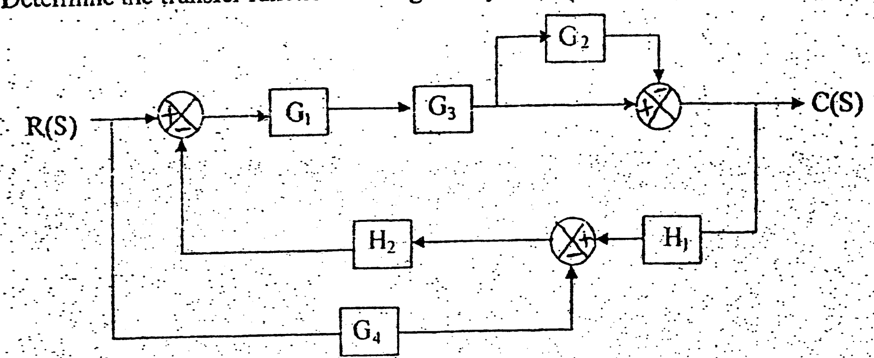
1. a) What is control system? Draw the block diagram of a closed loop control system and briefly explain the function of each block. [5]

   b) Show that the speed of response increases with the increase of the gain of the system. [3]

   c) Find the transfer function $\frac{\theta_m(S)}{V_a(S)}$ of the system below by constructing the block diagram. [8]



2. a) Determine the transfer function of the given system by reducing blocks. [8]



   b) Consider a unity feedback control system with the closed loop transfer function

$$\frac{C(S)}{R(S)} = \frac{Ks + b}{(s^2 + as + b)}$$

   Determine the open loop transfer function. Show that the steady state error in the unit ramp input response is given by [5]

$$e_{ss} = \frac{a-k}{b}$$

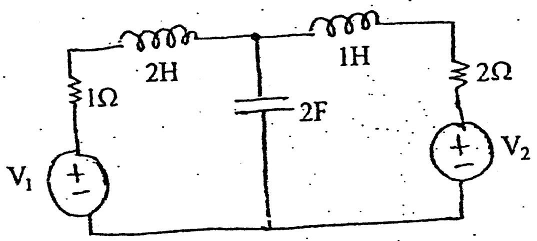
   c) How we can perform relative stability analysis using RH-Criteria? [3]

3. a) For a unity feedback system the open loop transfer function of a control system is given by [10]

$$G(S) = \frac{k}{s(s+4)(s^2+4s+20)}$$

Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions.

b) Write the state equation for the circuit shown below. Also write output equation. [6]



4. a) Discuss working of PI controller. [4]

b) Suppose that the step response of a first order system is $C(t) = 5(1 - e^{-t/5})$. What are impulse and ramp responses? [4]

c) Sketch the Nyquist Plot of Unity feedback system having open loop transfer function and $G(S)H(S) = \frac{s+10}{(s-3)(s+3)}$. Comment on stability. What is gain margin? [8]

5. a) Discuss the purpose of lead and lag compensators. [4]

b) Design a suitable phase lag compensating network for $G(S) = \frac{k}{S(1+0.1s)(1+0.2s)}$ to meet the following specification [12]

$K_v = 30\ \text{Sec}^{-1}$

$P.M \ge 40°$

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21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

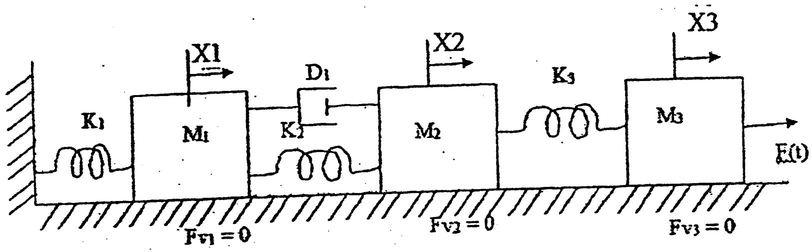
Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE602)*

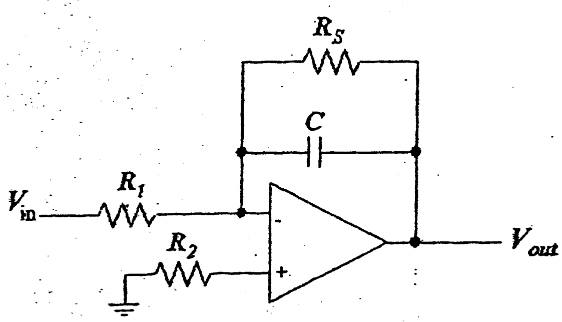
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) How would a closed loop system differ from open loop one on its steps response? Give analytical explanation. [6]

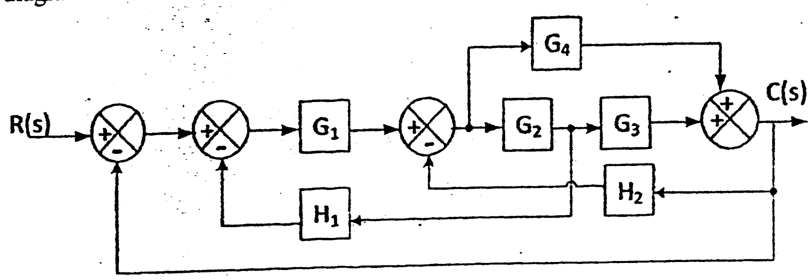
   b) Find the transfer function, $\frac{X2(S)}{F(S)}$, for the mechanical system of figure below. Also draw the F-V and F-I analogy circuit of the system. [6]



   c) Find transfer function of an op-amp model as below. [4]



2. a) Determine the overall transfer functions C(s)/R(s) of the given system by block diagram reduction technique. [8]



   b) Using R-H criteria, tell how many roots of polynomial given below is in right half s-plane, in left half s-plane and on jw axis. Comment on stability. [8]

$$s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$$

3. a) The open loop transfer function of a control system is [8]

$$G(s)H(s)=\frac{(4s+1)}{s^2(s+1)(2s+1)}$$

Using Nyquist criterion, determine the open loop and closed loop stability of this system.

b) The open loop transfer function of a unity feedback system is given by [8]

$$G(S)=\frac{108}{S^2(s+4)(s^2+3s+12)}$$

Find the static error coefficients and steady state error of the system when subjected to an input given by $r(t)=2+5t+8t^2$

4. a) Draw Bode Plot for the system with transfer function $G(s)=\frac{20s+200}{(s^2+4s+25)(s^2+40s)}$.

Determine gain margin, phase margin and comment on stability of the system according to your plot. [8]

b) Given state equation and output equation, find transfer function $\frac{Y(S)}{U(S)}$ and determine the poles and zeros. [8]

$$\dot{X}=\begin{bmatrix}0 & 1 & 0\\ -1 & -1 & 0\\ 1 & 0 & 0\end{bmatrix}X+\begin{bmatrix}0\\ 1\\ 0\end{bmatrix}u \quad \text{and} \quad y=\begin{bmatrix}0 & 0 & 1\end{bmatrix}X$$

5. a) State whether the statement "Derivative controllers are always used with other controllers" is true or false and justify your answer. [1+3]

b) Design a lead compensator for a system having open loop transfer function $G(s)H(s)=\frac{k}{s(1+0.1s)(1+0.001s)}$ so that the designed system should have PM $\geq 45°$, $K_v=1000\ \text{sec}^{-1}$ [12]

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21 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Chaitra

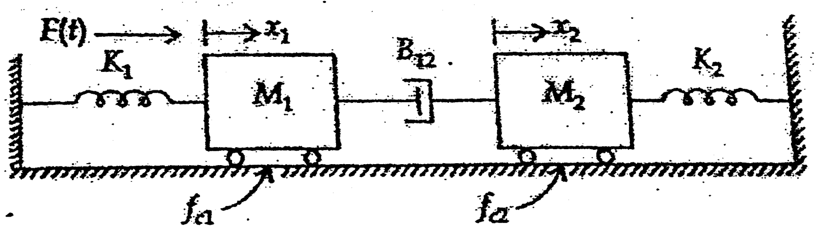
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE602)*

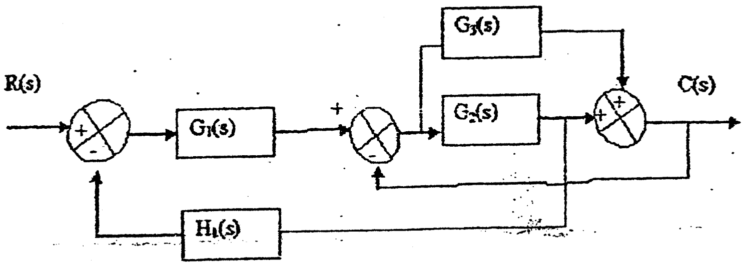
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? Draw the block diagram of a closed loop control system and briefly explain the function of each block. Mention also the advantages of closed loop system over open loop system. [8]

   b) Construct the free body diagram and write the differential equations for the mechanical system given below and determine $X_2(s)/F(s)$. Also draw F-V analogy of the system below. [2+2+2+2]



2. a) Using Masons gain formula, find the tr, Function $\frac{C(S)}{R(S)}$ of the figure given below. [8]



   b) The system below in figure (a) when subjected to a unit step input, the output response is as shown in figure (b). Determine the value of K and T. [8]

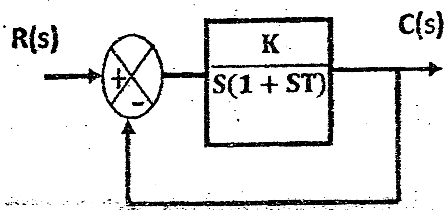


Fig a

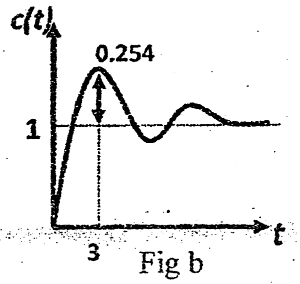


Fig b

3. a) Construct Routh array and determine the stability of the system whose characteristic equation is $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Comment on the location of the roots of characteristic equation. [6]

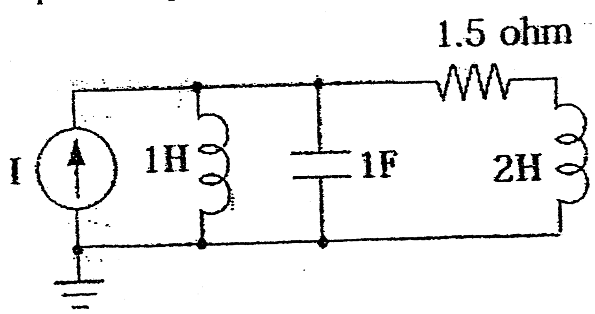
b) For a unity feedback system, the open loop transfer function of a control system is given by:

$$G(S) = \frac{K}{s(s+2)(s^2+6s+25)}$$

Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

4. a) Using Nyquist criterion, determine the stability of the feedback system whose open loop transfer functions is given by $G(s)\,H(s) = \dfrac{1}{s(1+2S)(1+S)}$ [8]

b) Develop state space equations for the following circuit considering voltage of 1F capacitor as output. "I" is input to the system. [8]



5. What would happen if zero is added to left half s-plane? Design a lead compensator for a unity feedback system with its feedforward transfer function as $G(s) = \dfrac{4}{s(s+2)}$ such that its settling time would be 2 sec but without change in maximum percent overshoot of its unit step response. Also velocity error constant should not be less than 2.5 per sec. [2+14]

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

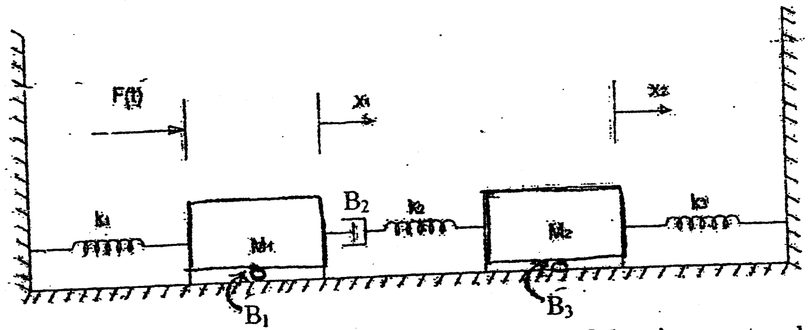
Subject: - Control System *(EE602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

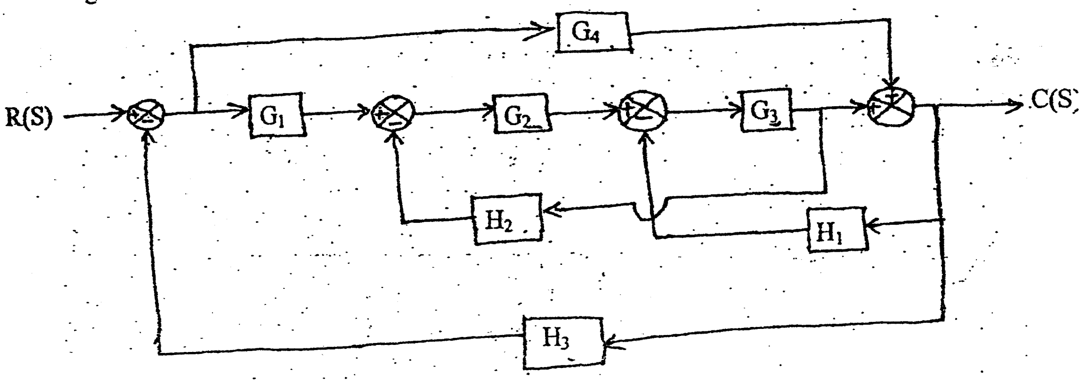
1. a) What kind of control system could have been in the following? Illustrate with necessary blocks and variables. [4×2]

   i) Governer system of Hydropower Station
   ii) Traffic light system of Kathmandu

   b) Find transfer function (consider displacement of mass M2 as output) for the given mechanical system. Also develop force-current analogous circuit. [8]



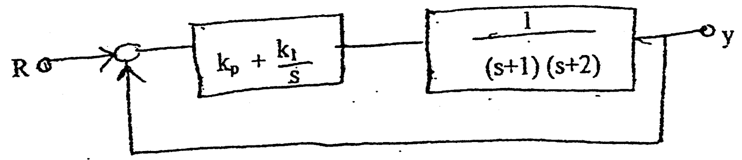
2. a) Determine the overall transfer functions C(S) / R(S) of the given system by block diagram reduction technique. [8]



   b) The system equations are given by: $\dot{x}(t)=\begin{bmatrix}0 & 1\\ -5 & -6\end{bmatrix}x(t)+\begin{bmatrix}0\\1\end{bmatrix}u(t)$; and

   $y(t)=[1 \quad 0]x(t)$; Find transfer function of the system and also check stability. [8]

3. a) For a closed loop system presented by [4]



Determine the range of controller gain (K_p, K_I) so that the PI controller provides the stable output.

b) A unity feedback control system has an open loop transfer function $G(S) = \dfrac{K(S+9)}{S(S^2+4S+11)}$. Sketch the root locus and determine: [8]

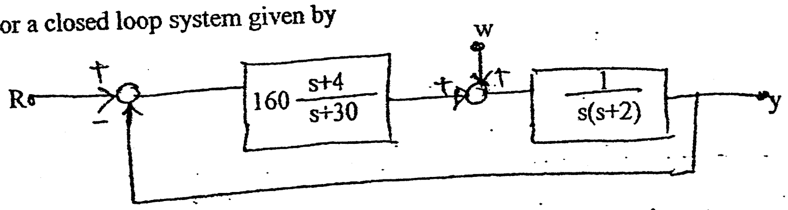
i) The range of 'K' for system to be stable
ii) Undamped natural frequency of oscillation

c) A closed loop servo is represented by the differential equation $\dfrac{d^2y}{dt^2} + 8\dfrac{dy}{dt} = 64z$ where 'y' is the displacement of the output shaft and 'u' is the displacement of the input shaft and z = u-y. Determine frequency of sustained oscillation, damping ratio and percentage maximum overshoot for unit step input. [4]

4. a) Draw the region in S-plane that satisfies following requirements. [4]

i) $S > 0.707$ (ii) $t_s < 2$ S

b) For a closed loop system given by [8]



i) Can the system track a step reference input 'r' with zero steady state error
ii) Can the system reject a step disturbance 'ω' with zero steady state error?
iii) Compute the sensitivity of closed loop transfer function to change in the plant pole at '-2'

c) How a controller with transfer function $G_c(S) = \dfrac{1+aTS}{1+TS}$ can be used as lead or lag compensator, explain. [4]

5. a) Design a suitable lead compensator for a system whose open loop transfer function is given by $G(S) = \dfrac{K}{s(1+0.2s)}$ [10]

The system should meet the following criteria

i) $K_v \geq 20\,\text{sec}^{-1}$
ii) P.M. $\geq 44°$

b) The differential equations related to a system are $\dfrac{dx_1}{dt} = -3x_1 + x_2$ and $\dfrac{dx_2}{dt} = -2x_1 + u$ for $t > 0$. Its output equation is given by $y = x_1$. Derive the transfer function of the system with these differential equation and output equation. [6]

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21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

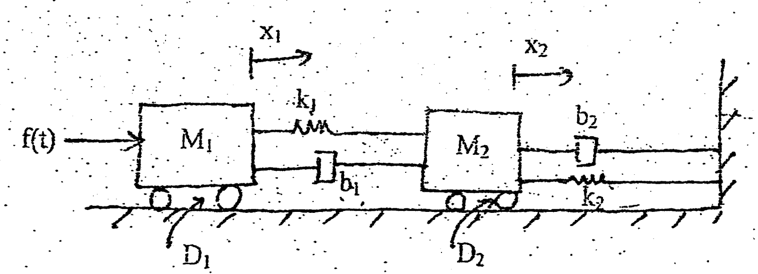
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE602)*

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt All questions.*
- *The figures in the margin indicate Full Marks.*
- *Assume suitable data if necessary.*

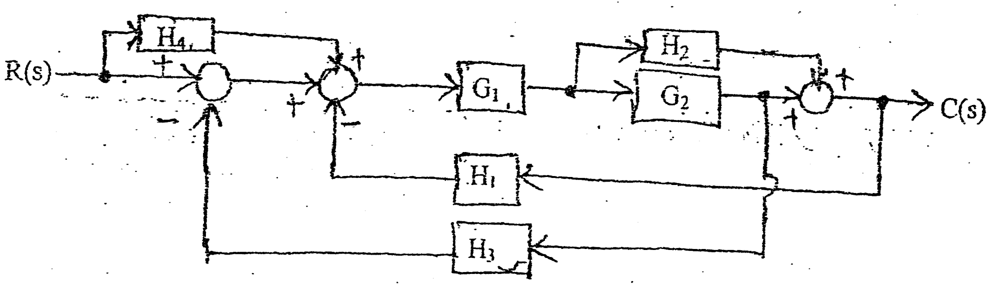
1. a) Define linear time invariant system. Justify the statement "modern complex systems are more pronounced with closed loop control system". [4]

   b) The given mechanical system has force f(t) as input and x_1 and x_2 as displacement outputs. Draw equivalent F-V analogous circuit and determine the transfer functions $X_1(S)/F(S)$ and $X_2(S)/F(S)$. [8]

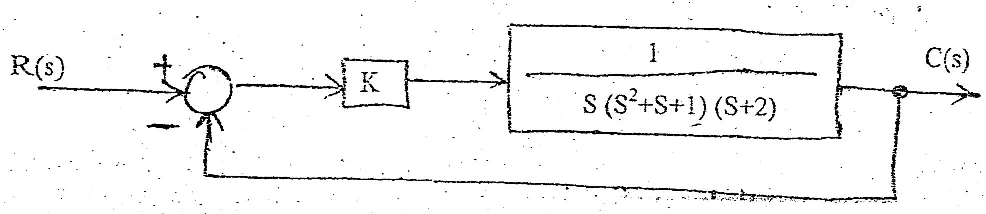


   c) Discuss, how a closed loop system has better disturbance rejection and command input tracking capabilities in comparision to an open loop system. [4]

2. a) Find Transfer function of the following system. [8]

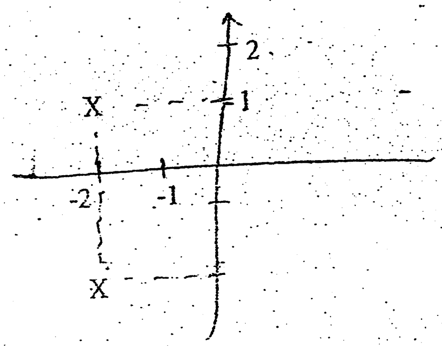


   b) Find the range of 'K' for stable operation using R-H criteria. [4]



   c) Explain how RH (Routh Hurwitz) method is used for determining relative stability. [4]

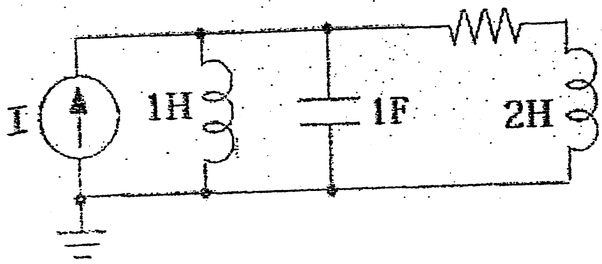
3. a) Open loop pole/zero plot of a unity feedback system are shown in figure below. Determine maximum overshoot and setting time for its step response. [6]



b) If desired damping ratio is '1', which controller do you suggest, explain. [4]

c) Determine value of 'K' and 'b' so that the unity feedback system with open loop transfer function; $G(s)=\dfrac{K(s+1)}{s^3+bs^2+3s+1}$ [6]

4. a) Develop state space equations for the following circuit considering voltage of 2H inductor as output. I is input to the system. [6]



b) Draw Bode plot for the system with transfer function $G(s)=\dfrac{4s+40}{(s^2+4s+25)(s^2+50s)}$.

Determine gain margin, phase margin and comment on stability of the system according to your plot. [10]

5. a) Compare the Lag and Lead compensator applications in control system. [4]

b) Design a suitable compensator for a unity feedback system with its feed forward transfer function as $G(s)=\dfrac{4}{s(s+2)}$ such that its maximum percent overshoot 16.3% and settling time 2 sec. for its step response. Also velocity error constant should not be less than 2 per sec. [12]

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21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE602)*

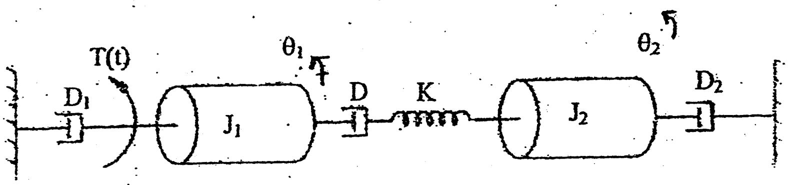
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary graph paper and semilog graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? Mention its type and explain them with example and block diagram showing all necessary blocks and signals. [8]

   b) Explain the role of PD controller on transient and steady state performance specifications. [4]

   c) Explain why closed loop system has better disturbance rejection capability than open loop. [4]

2. a) Find transfer function of the system given below (take angular displacement of J_2 as output). Also develop Torque-Voltage analogy circuit. [8]



   b) What are the static error constants? Explain how they are applied in measuring steady state performance of given system. [4]

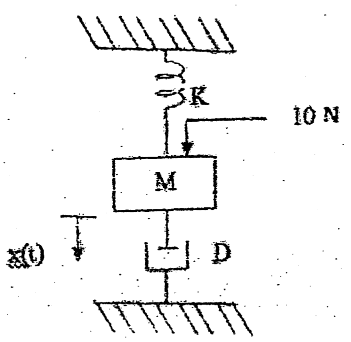
   c) Use RH criteria to find the position of roots of characteristic equation given by

   $C(s) = s^5 + 4s^4 + 2s^3 + 8s^2 + s + 4$; and hence determine the stability of the system. [4]

3. a) Construct the root locus for unity feedback system with OPTF $G(s) = \dfrac{k(s+2)}{s(s-1)}$ Hence show that the system is unstable for small value of gain and over damp at larger value of gain. [8]

   b) Discuss how the poles and zeros affect system dynamics. [4]

   c) Following figure shows a mechanical system and the response when 10 N of force is applied to the system. Determine the value of M, D and K. The displacement x is measured from the equilibrium position. [4]



4. a) Design a suitable compensator using root locus for a UFS with $G(s)=\frac{10}{s(s+1)(s+4)}$ to meet the specifications; damping ratio = 0.5 and undamped natural frequency = 2 rad/s. [12]

b) Define relative stability. Discuss how nyquist plot is used to determine the stability of a system. [4]

5. a) For a unity feedback system with $G(s)=\frac{250k}{s(s+50)(s+5)}$, select the value of 'k' so that the steady state error for a ramp input is 10%. At this value of 'k', construct the Bode plot. Hence determine approximate gain margin, phase margin, gain cross over frequency and phase cross over frequency. [8]

b) Given state equation and output equation, determine the poles and zeros of given system. [8]

$$X=\begin{bmatrix}0 & 1 & 0\\-1 & -1 & 0\\1 & 0 & 0\end{bmatrix}X+\begin{bmatrix}0\\1\\0\end{bmatrix}u \text{ and } y=\begin{bmatrix}0 & 0 & 1\end{bmatrix}X$$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

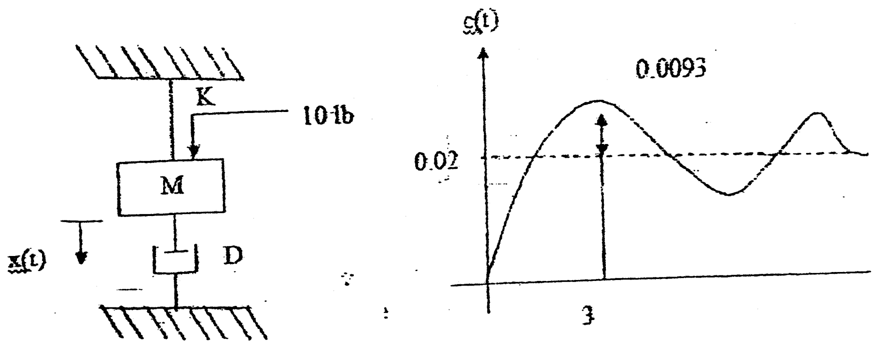
Subject: - Control System *(EE602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

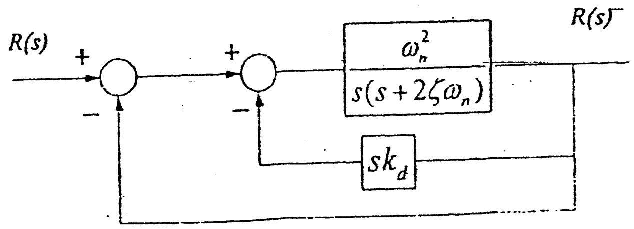
1. a) Construct a general block diagram of a control system showing the different blocks, variables and hence briefly point out their meaning. [4]

   b) Effect of disturbance in case of feedback control system can be suppressed by increasing the gain G(S) and / or H(S). [4]

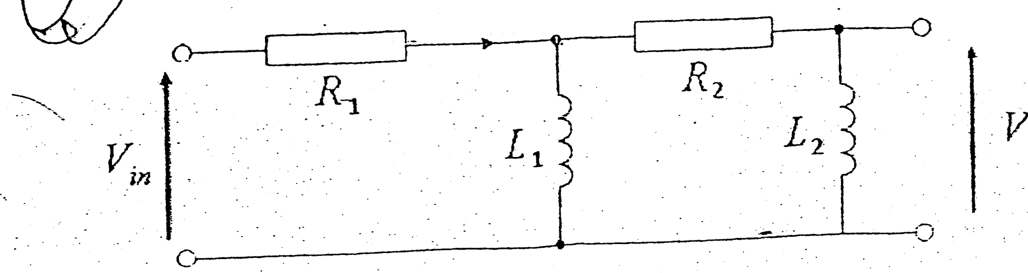
   c) Following figure shows a mechanical vibratory system and the response when 10 lb of force is applied to the system. Determine the transfer function and value of M, D and K. The displacement x is measured from the equilibrium position. [8]



2. a) Show that using the velocity feedback techniques shown figure below damping ratio and steady state error are both increased. [8]



   b) Develop block diagram model for the system below. [6]



c) Using R-H criteria, tell how many roots of polynomial is in right half s-plane, in left half s-plane and on jw axis and also comment on stability. [4]

$$S^6 + 3S^5 + 4S^4 + 6S^3 + 5S^2 + 3S + 2 = 0$$

3. a) For the unity feedback system with open loop transfer function (OLTF) $G(s) = \dfrac{k}{(s+1)(s+3)}$, use angle criteria to check whether the root locus passes from point $s_d = -2 + j3.5$. If yes, use magnitude criteria to select the appropriate value of gain parameter. [4]

b) For a system given by $\dfrac{d}{dt}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -5 & -6 \\ 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix}u; y = \begin{bmatrix} 1 & 2 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$, determine the zeros and the poles of the system. [4]

c) The open loop transfer function of a control system is given by [8]

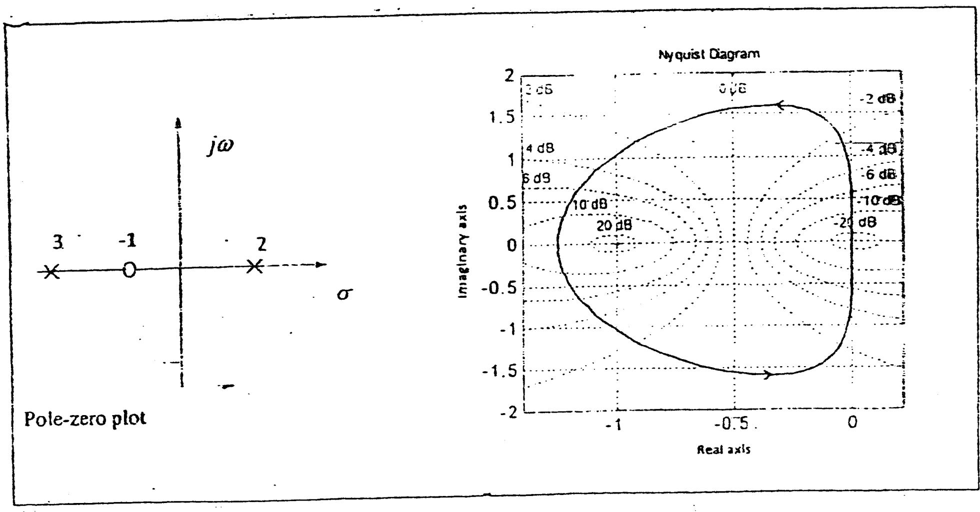
$$G(s)H(s) = K\frac{s^2 - 2s + 5}{s^2 + 1.5s - 1}$$

Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. Also find value of K that gives poles at $(-0.35 \pm j0.6)$

4. a) Design a suitable compensator for a unity feedback system with open loop transfer $G(s) = \dfrac{4}{s(s+2)}$ such that the settling time will become 2 seconds without change in overshoot and velocity time constant will be $2\ s^{-1}$. [12]

b) For a compensator transfer function given by $G_c(s) = \dfrac{s+\tau}{s+a\tau}$, give the condition of lead compensator. For the given value of 'a' what is the frequency that leads to maximum phase angle lead. [4]

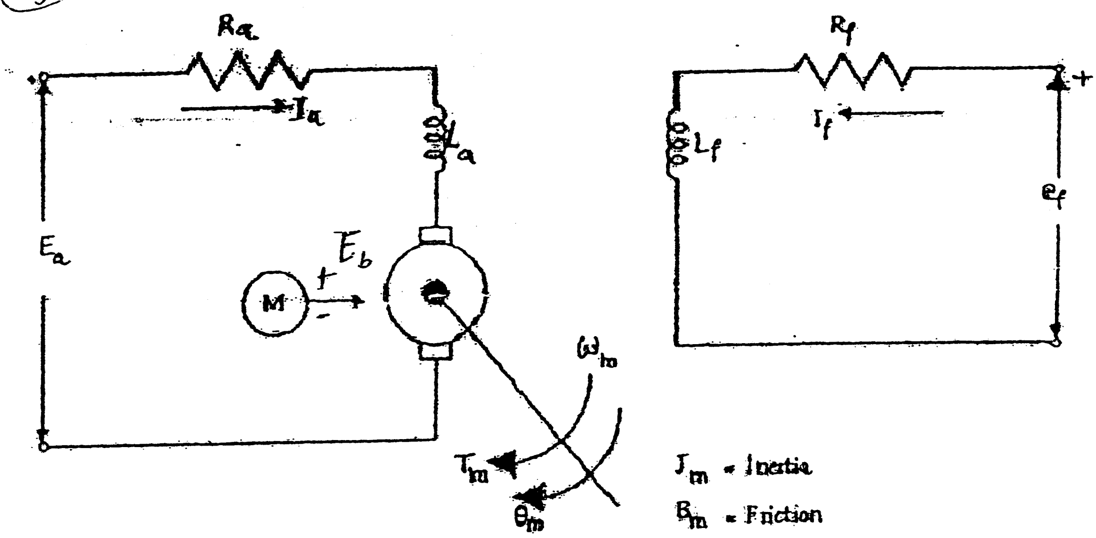
5. a) State the Nyquist stability criteria for negative feedback control system. Using this concept determine whether the following system represented by figure below is stable. [4]



Pole-zero plot

b) Discuss how bode plot can be used to determine transfer function of the system. [5]

c) Develop state equation for motor circuit at below. [5]



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2071 chaitra

control system

INSTITUTE OF ENGINEERING

Examination Control Division

2071 Shawan

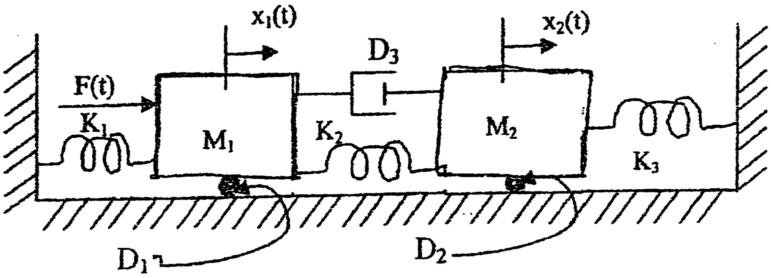
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System *(EE602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? Draw the block diagram of a closed loop control system and briefly explain the function of each block. Mention also advantages of closed loop system over open loop system. [8]

   b) Find the transfer function, $\frac{X2(S)}{F(S)}$, for the mechanical system of figure below. Also draw the F-V and F-I analogy circuit of the system. [8]



2. a) Discuss how the dynamic responses of control system are affected by a feed back. [6]

   b) For an open loop transfer function with unity feedback $G(S) = \frac{\omega_n^2}{s(s+2\xi\omega_n)}$ where $\xi < 1$, derive an expression for output when unit step input is applied. [4]

   c) Using R-H criteria, tell how many roots of polynomial is right half s-plane, in left half s-plane and on jw axis. [6]
   $$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$$

3. a) The open loop transfer function of a control system is given by
   $$G(S)H(S) = \frac{K}{s(s+6)(s^2+4s+13)}$$
   Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

   b) Discuss how a Bode plot can be used to determine transfer function of the system. Explain with an example. [6]

4. a) Construct the polar plot of unity feedback system with $G(S) = \frac{K}{S(S+1)(0.1S+1)}$. Then, upgrade the plot to make it. Nyquist plot. Hence find range of k for stable operation. [3+3+2]

   b) For given state equation and output equation, find transfer function $\frac{Y(S)}{U(S)}$ [8]

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} X$$

Design a suitable lead compensating network for $G(S) = \frac{k}{s^2(1+0.25s)}$ to meet the following specification $Ka = 10\ sec^{-1}$

P.M $\ge 35°$ [16]

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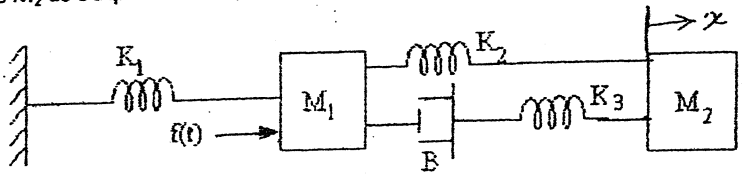
21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

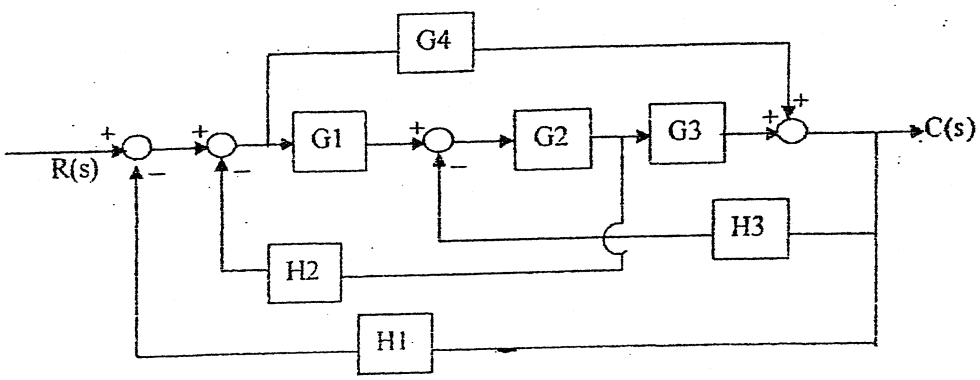
Subject: - Control System *(EE602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. (a) Find transfer function for the following mechanical system considering displacement of mass M_2 as output of the system. Also develop force current analogous circuit. [6]

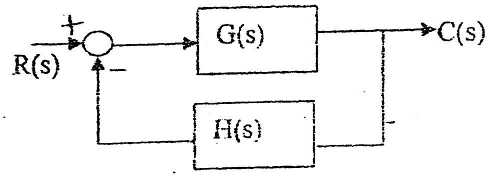


(b) Reduce the following block diagram model to obtain its overall transfer function. [6]



(c) How can you characterize a control system in term of (i) Speed (ii) accuracy (iii) Stability explain. [4]

2. (a) For a second order system as below $G(s) = \frac{w_n^2}{s(s+2\xi w_n)}$ and H(s) =1, find expression for maximum overshoot on its unit step response where w_n is natural frequency of oscillation and ξ is damping ratio at underdamped situation. [7]



(b) Discuss how a feed back control system reject the disturbance input. [3]

(c) Find all static error constant for a unity feedback system with feedforward transfer function $G(s) = \frac{1000}{s(s+10)(s+100)}$. Evaluate steady state error if system is excited with r(t) = 2+t. [6]

3. (a) Obtain Nyquist plot and comment on stability using Nyquist Criterion for a unity feedback system with feedforward transfer function $(s) = \frac{(s+2)}{(s+1)(s-1)}$. [8]

(b) Discuss how Bode plot is used for determining relative stability. [4]

(c) Discuss the application of a PI controller with suitable example. [4]

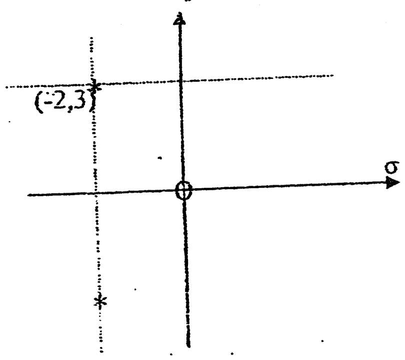
4. (a) Obtain characteristic equation for the system having given state model. [4]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(b) Design series lag compensator for the unity feedback system with feedforward transfer function $G(s) = \frac{K}{s(s+4)(s+80)}$. The velocity error constant is $30 s^{-1}$ and phase margin at least 33^0. [12]

5. (a) Draw Root Locus for the system that has open-loop pole/zero plot in s-plane as below in figure. Also estimate the system gain at the point where the system exhibits critical damping. [8]



(b) The open loop transfer function of a closed loop system is $(s) = \frac{K(s+1)}{s(s+2)(s+3)}$, find maximum possible K for which the poles lie on left of point -0.5. [8]

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

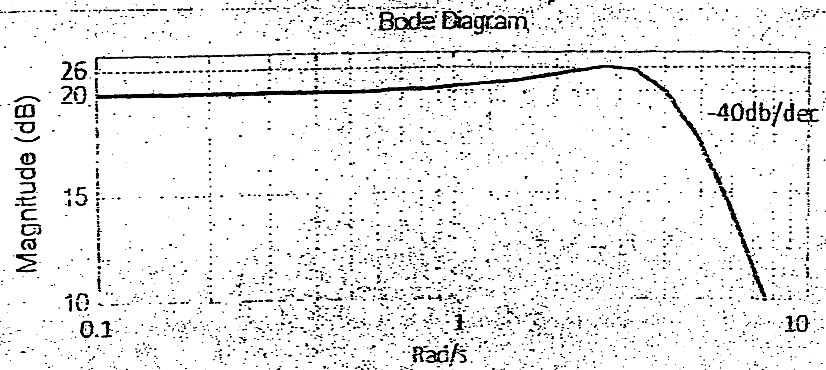
Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Control System (EE 602)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Semi-log paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. (a) For a unity feedback system with open loop transfer function (OLTF) $G(s)=\dfrac{k}{(s+0.2)(s+1)(s+5)}$, generate *Nyquist plot* of the system to find the range of 'k' for stable operation At k = 10, what will be the value of phase cross over frequency and gain margin. [6]

   (b) For an approximate *Bode Plot* of a close loop system as shown below, evaluate the following performance indices: (i) maximum overshoot (ii) peak time. [4]



2. (a) Deduce the state space model of transfer function given by $G(s)=\dfrac{s^2+1}{s^3+5s^2-2s+1}$. [4]

   (b) Evaluate the state transition matrix of system represented by $\dfrac{d}{dt}\begin{bmatrix}x_1\\x_2\end{bmatrix}=\begin{bmatrix}-5 & -6\\1 & 0\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix}+\begin{bmatrix}1\\0\end{bmatrix}u$ [4]

   (c) For a unity feedback system with OLTF $G(s)=\dfrac{a}{s(s^2+s+1)(s+2)}$, find the range of 'a' for stable operation. At which of 'a', system become marginally stable; and also calculate undamped frequency of oscillation. [8]

3 (a) For the unity feedback system with OLTF $G(s)=\dfrac{k}{(s+1)(s+3)}$, use angle criteria to check whether the root locus passes from point $s_o=-2+j3.5$. If yes, use magnitude criteria to select the appropriate value of gain parameter. [4]

(b) For the unity feedback system with OLTF $G(s)=\dfrac{k(s+3)}{(s-1)(s^2+2s+4)}$, plot the root locus and find the range of gain parameter (k) for the system for unstable, under-damped, over-damped conditions. [8]

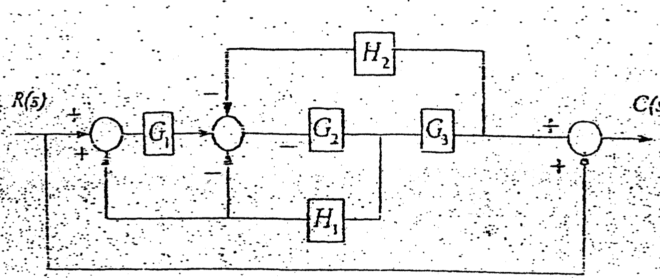
4

(b) Design a compensator using Bode plot for a unity feedback system with OLTF $G(s)=\dfrac{k}{s(s+2)(s+20)}$ to meet the specifications: $PM \geq 35^0$, $K_v \geq 20\ s^{-1}$, such that the bandwidth of the resultant system decreases. [12]

5.(a) How do you characterize control systems in term of their indices like speed, accuracy, stability and robustness? [4]

(b) What do you mean by force voltage analogy of a mechanical system? Explain with examples. [4]

(c) Convert the following block diagram into signal flow graph and hence use Mason Formula to get transfer function. [8]



6.(a) For a mechanical system with close loop transfer function, $\dfrac{\theta(s)}{T(s)}=\dfrac{1}{as^2+bs+c}$; where $\theta(s)$ the output of step input T(s)=10 Nm. Determine values of 'a', 'b', and 'c'; if maximum overshoot =6% peak time (t_p)=1 sec, and e_{ss} =0.5. [6]

(b) What are the performances indices of control system in time domain, explain with suitable diagram or graph. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2069 Chaitra

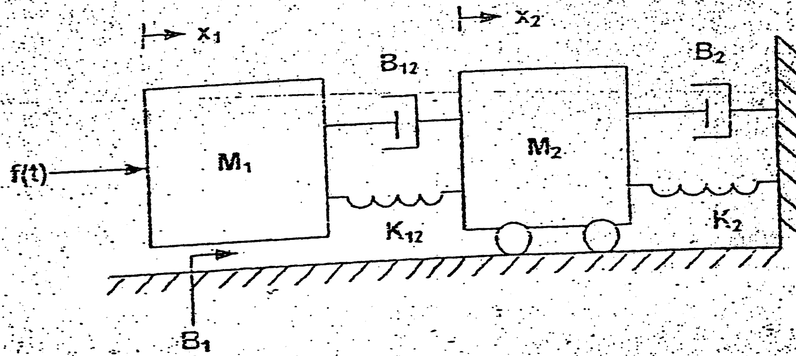
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BME, BIE	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Control System (EE602)

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt **All** questions.*
- *The figures in the margin indicate **Full Marks**.*
- *Bode plot and normal graph paper would be provided.*
- *Assume suitable data if necessary.*

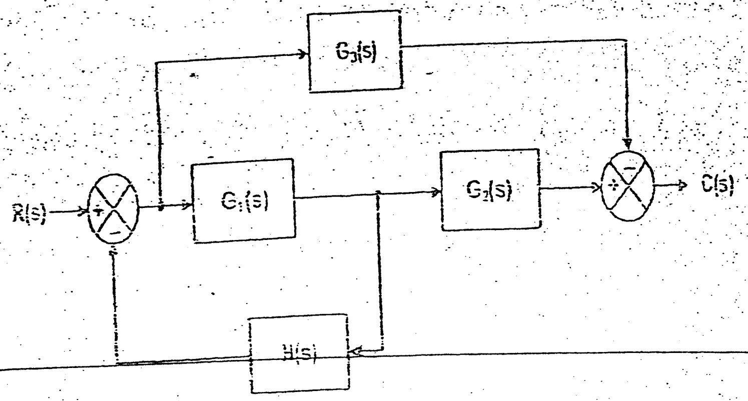
1. Stating an example of a system that you see in everyday life, explain what do you understand by closed loop system and the importance of feedback in it. [4]

2. Write the differential equations governing the mechanical system shown in figure below and find $\frac{X_2(s)}{F(s)}$ [8+4]



Also tabulating the necessary analogies draw the Force-Current and Force-Voltage electrical analogous circuit.

3. a) Convert the given block diagram to signal flow graph and determine the overall transfer function using Masson's Gain Formula. [6]



b) Consider a unity feedback system with a closed loop transfer function [6]

$$\frac{C(s)}{R(s)} = \frac{Ks+b}{s^2+as+b}$$

Determine the open loop transfer function G(s). Also compute the steady state error ... input

4. The characteristics equation of a system is given by $S^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$. Comment on the stability. [6]

5. Plot the root loci for closed loop system with $G(S) = \frac{K}{S(S+1)(S^2+4S+5)}$, $H(S) = 1$. Also determine the dominant closed loop pole with $\xi = 0.5$. [12]

6. Draw the bode plot for transfer function $G(S) = \frac{48(1+s)}{(s^2)(1+3s)(1+0.5s)(2+0.2s)}$, from the graph determine (i) Phase crossover frequency (ii) Gain crossover frequency (iii) P.M (iv) G.M (v) Stability of the system. [10]

7. Design a suitable cascade lag compensator network for the given system $G(s) = \frac{50K}{s(s+5)(s+10)}$ [16]

Such that the requirement of velocity error constant of 30 sec^{-1} and phase margin of $\geq 45°$ are met.

8. A system has the transfer function $\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$ [8]

Find the state and output equation in matrix form and test the controllability and observability of the system.

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Instrumentation *(EX 504)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain different working environment of an instruments. [3]

   b) Sketch the block diagram of data acquisition system. [3]

2. a) Explain the measurement of capacitance using Schering Bridge. [4]

   b) A moving coil ammeter has a uniform scale with 50 divisions and gives full scale reading of 5A. The instrument can read upto one-fourth of the full scale division with a fair degree of certainty. Determine the resolution of instrument in mA. [4]

3. Describe loading effect in a potentiometer and discuss the methods to reduce loading effect in a potentiometer. Also prove that linearity and sensitivity are two conflicting requirements in a potentiometer. [8]

4. What are the benefits of microprocessor based system? [4]

5. The address captured by 8255 PPI are C0C0H to C0C3H. Sketch the interfacing circuit with 8085 microprocessor in memory mapped I/O for same. What will be the control words for following configurations of 8255 PPI? [2+2+2+1+1]

   a) Port A: Mode 0 output
      Port B: Mode 0 input
      Port C: Mode 0 output

   b) Port A: Mode 1 output
      Port B: Mode 1 input
      $PC_{4,5}$: Output

   c) Port A: Bidirectional
      Port B: Mode 1 output

   d) Set PC_5 in BSR mode

6. a) Describe the functions of RS232C signals used in handshaking. [4]

   b) What is Enumeration in USB protocol? Describe different types of packets used in USB Protocol. [4]

7. Explain how do you interface a 10-bit DAC with 8085 in detail. [5]

8. Explain the different types of filtering mechanism used to reduce conductive noise coupling based on frequency. [5]

9. Explain reliability and fault tolerance in the context of circuit design. [5]

10. Explain the general rules to follow while doing the component placement. List out the factors that should be considered in routing the signal traces on printed circuit board (PCB). [3+2]

11. Explain about spiral model of software development life cycle in detail. [5]

12. Explain the construction and working principle of dynamometer type single phase power factor meter. [5]

13. Draw the complete block diagram of the industrial process control involved in your case study. What are the critical factors affecting the production you have noticed in the visited industry and what are the measures can you suggest for the same? Also mention advantages and disadvantages of suggested system. [8]

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 Baishakh

Exam.		Back	
Level	BE	**Full Marks**	80
Programme	BEI	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Instrumentation (*EX 504*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define signal. Compare between analog and digital signals. Explain data compression techniques. [2+2+2]
2. Explain static characteristics of measurement system: Accuracy and Precision. Describe the measurement of inductance using Maxwell Bridge. [3+5]
3. a) Explain the working of a capacitance transducer based on change in distance between plates. [4]

   b) The output of an LVDT is connected to 5 mV voltmeter through amplifier whose amplification factor is 250. An output of 2mV appears across terminals of LVDT when the core moves through a distance of 0.5 mm. Calculate the sensitivity of LVDT and that of whole set up. The milli voltmeter scale has 100 divisions. The scale can be 1/5 of the division. Calculate the resolution of the instrument in mm. [4]
4. Define microprocessor-based instrumentation system. Mention its advantages and disadvantages. [4]
5. Port A is designed as input for a keyboard with interrupt I/O and port B as output port for a printer with status check I/O of 8255 in mode 1 and I/O mapped I/O. [2+1+1+1+1+2]

   a) Draw the block diagram representation for the given statement with appropriate logic for CS' of 8255.

   b) Find the port addresses.

   c) Determine the control word to set up port A as input and port B as output.

   d) Determine the BSR word to enable $INTE_A$.

   e) Determine the masking byte to verify OBF_B' line for port B.

   f) Write initialization instructions and a printer subroutine to output characters that are stored in memory.
6. Mention the advantages of serial interface over parallel interface. Compare among RS 232, RS 422 and RS 423. [3+5]
7. Explain the interfacing of 8-bit DAC with 8085 MPU. [5]
8. Describe the different mechanism of energy coupling. [5]
9. Discuss about reliability and fault tolerance in the context of circuit diagram. [5]
10. Explain common impedance and trace density in routing signal traces. [5]
11. Describe prototyping model of software development with advantages and disadvantages. [5]
12. Explain the working principle of Electrodynamometer Wattmeter. [5]
13. Discuss the current mechanism of the industrial process control system involved in your case study with its block diagram. Draw the new instrumentation system that you have designed for betterment and explain it. Also mention advantages and disadvantages of implementing this new control system. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Instrumentation *(EX 504)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt **All** questions.*
✓ *The figures in the margin indicate **Full Marks**.*
✓ *Assume suitable data if necessary.*

1. a) Define analog and digital signals. Differentiate between analog and digital systems. [1+3]
   b) What is a data logger? What are its applications? [2]
2. a) Distinguish between static and dynamic characteristics of a measurement system. Describe various parameters used to study these characteristics. [4]
   b) Explain quality factor in Maxwell's bridge? Why is it not suitable to use a Maxwell bridge for measuring the inductance of a large quality factor (Q > 10)? [4]
3. a) Explain the working principle of LVDT for the measurement of displacement. [4]
   b) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of inner electrode is 5 mm and the dielectric medium is air. The inner diameter of outer electrode is 5.1 mm. Calculate the dielectric stress when a voltage of 120V is applied across the electrode. Is it within the safe limit? The length of electrode is 20mm. Calculate the change in capacitance if electrode is moved through a distance of 2 mm. The breakdown strength of air is 4 kV/mm. [4]
4. Design an interface arrangement for 8085 microprocessor to map output ports in address space 85 H and input ports in address space 89 H. [4]
5. A dairy factory uses an 8255 PPI card at base address 5000 H.
   a) Explain how port address is changed with the change in address lines of 8085 connected with 8255. [2]
   b) How do you initialize a control word for 8255? [2]
   c) Write a program to read data from port B and display at port A and also, data from port C_U to C_L. [4]
6. a) Describe the various error detection techniques used in data communication. [4]
   b) Discuss the types of data packets used in USB protocol. [4]
7. How can you interface 10 bit DAC with 8085? Explain. [5]
8. What is the general principle of grounding? Explain the capacitive noise coupling mechanisms in electronic circuits. [1+4]
9. During circuit design process, what are some general technical dilemmas faced by engineers? Explain how an engineer can arrive at an optimal solution given the requirements of a customer. [5]
10. Define impedance matching and ground bounce? What are the different ways of reducing crosstalk when routing signal traces on a PCB? [2+3]
11. Explain spiral software development model with its advantages and disadvantages. [5]
12. Explain the constructional detail and working principle of electrical resonance type frequency meter. [5]
13. Discuss the current control system and methodology of the instrumentation system involved in your case study with necessary block diagram. What are the suggestions and recommendations you would provide to enhance the current system. Explain with necessary reasons why your recommendations should be implemented. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Instrumentation *(EX 504)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. Sketch the block diagram of generalized measurement system. [3]
2. a) If Voltmeter having accuracy of 1% and full scale range of 100v is used to measure (i) 80 v and (ii) 12 v. How accurate will the reading be? Comment your answer. [4]
   b) Explain the method used to measure inductance of coil with circuit diagram. [4]
3. Explain in detail about Optical Pyrometer with its advantages and limitations. [8]
4. Draw and explain the block diagram of microprocessor based instrumentation system. [4]
5. The addresses captured by 8255A PPI are D0D0H to D0D3H. What are the addresses captured by the card? Sketch the interfacing circuit with 8085 microprocessor in memory mapped I/O. Write the control word for following configuration. [1+2+2+1+2]
   a) Port A: Mode 1 input
      Port B: Mode 1 input
      Port $C_{6,7}$: output
   b) Set PC2 in BSR mode
   c) Port A: Bidirectional Port
      Port B: Mode 1 I/P
6. What are errors in serial data transmission? Explain error detection techniques in serial transmission. Explain USB-OTG in brief. [3+3+2]
7. Explain the operation of Flash type ADC with suitable example. [5]
8. Explain the Bluetooth network topology. [3]
9. Explain the various corrective strategies for different energy coupling mechanisms. [5]
10. What are the factors that describe reliability of an electronic system? Describe the working principle of decoupling capacitors in short. [3+2]
11. Write about the factors we should considered while doing component placement. How do you reduce crosstalk when routing signal traces on PCB? [3+2]
12. Explain the process of software development using Spiral model. [5]
13. Explain in detail about Induction type single-phase Energy meter. [5]
14. Explain the existing system involved in your case study with necessary block diagram. Recommend the changes that you deem necessary in the visited industry during your case study. [8]

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INSTITUTE OF ENGINEERING

Examination Control Division

2076 Bhadra

Exam.	[redacted]		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt* ***All*** *questions.*
- ✓ *The figures in the margin indicate* ***Full Marks.***
- ✓ *Assume suitable data if necessary.*

1. a) Explain the function of different stage of measuring system with the help of block diagram. [6]

   b) A voltmeter whose accuracy is 2% of the full scale reading is used on its 0-150V scale. It is used to measure a voltage of 75V and 37.5V. Calculate the maximum possible error of both readings. Comment on your answer. [4]

   c) How do you define error in a measurement system? How the Gaussian curves can be used to explain the normal distribution of random errors in a measurement? [6]

2. a) Which bridge is used for the measurement of unknown inductance of a coil having high quality factor? Explain how the measurement is done with the help of selected bridge and also explain the reasons behind the selection. [6]

   b) Define capacitive transducer. Explain how by using a differential arrangement a capacitive transducer which works on the principle of variation of capacitance with displacement between two plates the response can be made linear. [6]

   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of the inner electrode is 3mm and the dielectric medium is air. The inner diameter of the outer electrode is 3.1 mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrode. Is it within the safe limit? The length of the electrode is 20mm. Calculate the change in capacitance if the electrode is moved through a distance of 2mm. The breakdown strength of air is 3KV/mm. [4]

3. a) What is piezo electric transducer? What are the materials used in such transducer? Define voltage sensitivity, charge sensitivity and derive the expression for the output voltage developed due to applied force. [6]

   b) What are the ideal characteristics of an Op-amp? Derive the expression for close-loop gain in non-inverting mode of an Op-amp. [6]

   c) In a resistive potentiometer the maximum percentage error is 15 R_p / R_m where R_p and R_m are respectively the resistance of the potentiometer and the load respectively. A position measurement may have a maximum non-linearity of 0.5% when driving a load of 10 kΩ resistance. Find out the maximum value of resistance of potentiometer. [4]

4. a) Draw the block diagram of optical fiber communication system and write advantages of it. [6]

   b) Consider a 6-bit DAC with a resistance of 320 kΩ in LSB position. The converter is design with weighted resistor network. The reference voltage is 10V. The output of the resistive network is connected to an operational amplifier with a feedback resistance of 5 KΩ. What is the analog output for a binary input of 111010? [4]

   c) Describe the working principle of Successive Approximation ADC in detail with flowchart and diagram. [6]

5. a) Explain the working principle of dynamometer type wattmeter and prove that the deflection torque s directly proportion to power consumed by the load in both ac and dc circuit. [6]

   b) Show how the instrument transformers are used to measure high voltage and current. Also explain why secondary winding of CT should never be kept open circuited while primary is energized? [6]

   c) State and explain sampling theorem and define term analog signal and discrete signal. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define Instrumentation system with example. Explain the main elements of measurement system with the help of block diagram. [6]

   b) Differentiate between static and dynamic performance parameter with describing each parameter in brief. [4]

   c) A 1000 Hz bridge has the following constants: [6]
   Arm AB: R=1000Ω in parallel with C=0.5μF
   Arm BC: R=1000Ω in parallel with C=0.5μF
   Arm CD: R=200Ω in parallel with L=30mH
   Find the constants of Arm DA to balance the bridge express the result as a pure R in parallel with a pure C or L.

2. a) Explain how magnitude & direction of displacement can be measured using inductive sensor. [6]

   b) Explain working principle of capacitive sensor. Also explain how linear relation between output & input can be obtained in the case of capacitive sensor working on the principle of change in separation distance. [6]

   c) A strain gauge is bonded to a beam which is 12cm long & has a cross-sectional area of $3.8cm^2$. The unstrained resistance & gauge factor of the strain gauge are 220Ω & 2.2 respectively. On the application of load, the resistance of the gauge changes by 0.015Ω. If the modulus of elasticity for steel is 207 GN/m^2, calculate (i) the change in length of the steel beam. (ii) the amount of force applied to the beam. [4]

3. a) Explain the ideal characteristics of operational amplifier & derive the expression for closed loop gain in non-inverting mode. [6]

   b) Explain the "loading effect" on input-output relationship in measurement made by a potentiometer. How can the error due to loading be minimized? [6]

   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of inner cylindrical electrode is 3 mm and the dielectric medium is air. The inner radius of the outer electrode is 3.1mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrodes. Is it within safe limit? The length of electrode is 20mm. Calculate the change in capacitance if the inner electrode is moved through a distance of 2mm. the breakdown strength of air is 3KV/mm. [4]

4. a) Explain the method of Digital-Analog conversion using R-2R ladder network. Why do we prefer to use this DAC instead of WRN type, explain. [6]

   b) What is data acquisition system. Explain function of the different components of digital data acquisition system. [6]

   c) An 8 bit DAC has maximum supply voltage 12V. Find
   i) What voltage change does LSB represent?
   ii) What voltage change does MSB represent?
   iii) What voltage does 10111100 represent? [4]

5. a) State and explain Sampling theorem. What is aliasing? Define the terms analog signal and discrete signal. [8]

   b) Write short notes on: [2 x 4]
   i) Frequency meter
   ii) Instrument transformer

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2077 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain how probable error can be calculated with the help of statistical analysis in a measurement system. [6]

   b) Explain the difference between static and dynamic characteristics of measurement system. Also explain following static performance parameter. [6]
   (i) Accuracy
   (ii) Precision
   (iii) Sensitivity

   c) Following readling were obtained in respect of a capacitor: 1.003μF, 0.998μF, 1.001μF, 1.009μF, 1.005μF, 0.991μF, 0.996μF, 0.997μF, 1.008μF, & 0.994μF. Calculate:
   (i) Arithmetic mean
   (ii) Deviation from mean [4]
   (iii) Standard deviation

2. a) Explain how the liquid level can be measured by using capacitive sensor. [6]

   b) Define transducer with example. Explain the working principle of strain gauge and derive the expression for the gauge factor. [6]

   c) A linear resistance potentiometer is 50mm long and is uniformly wound with a wire of total resistance of 20kΩ. Under normal conditions, the slider is at the center of the potentiometer. Determine the linear displacement when the resistance of the potentiometer, as measured by wheatstone bridge are 1550Ω and 5600Ω. Are the two displacements in the same direction? If it is possible to measure a minimum value of 10kΩ resistance with the above arrangement, determine the resolution of the potentiometer in mm. [4]

3. a) Explain how both direction & magnitude of the displacement can be measured with help of linear variable differential transformer. [6]

   b) Describe the circuit of 3 amplifier configuration of an instrumentation amplifier. Also derive the expression for output voltage in terms of two input voltage. [6]

   c) Hall effect element is used for the measurement of magnetic flux of $0.8Wb/m^2$. The thickness of element is 2.5mm. If the current passed through the element is 5A, calculate the Hall emf developed. Given that $K_H=5\times10^{-7}$. [4]

4. a) Explain how analog to digital conversion is achieved by using ramp ADC. [6]

   b) What are the drawbacks of weighted resistor network? With suitable diagram explain the R-2R ladder digital to analog converter. [6]

   c) Given 12-bits, 10v successive approximation ADC that has 20μs conversion time and is used without sample and hold circuit. Find the maximum rate of change of input signal and its maximum frequency that can be applied. [4]

5. a) Explain the working principle of dynamometer type wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

   b) What is Data Acquisition system? Also explain the different component of analog [8]

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Instrumentation *(EX 504)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the essential components of Data Acquisition System? Explain it with the help of a block diagram. [4]

   b) What are the reasons to prefer pneumatic systems over hydraulic and electrical system? [2]

2. Obtain the balanced equation of an ac bridge and explain with diagram how Schering bridge can be used to measure unknown capacitance. [8]

3. What do you mean by piezoelectric effect? What are the different types of piezoelectric materials? Explain piezoelectric sensors in detail. [8]

4. Explain the types of microprocessor –based instrumentation system. [4]

5. Interface a printer and a keyboard in mode 1. Port A is designed as output for printer with status check I/O and port B is designed as input for keyboard with interrupt I/O.

   a) Draw the mapping circuit in I/O mapped I/O. [2]

   b) What are the port addresses captured by the PPI card. [2]

   c) Generate required control words. [1]

   d) Write initializing instructions and subroutines to read characters from keyboard and to send them to the printer. [3]

6. What are the errors in data communication? Compare and contrast Rs 232, Rs 422, and Rs 423 interfaces. [3+5]

7. Explain the working principle of successive approximation type of ADC. [5]

8. What do you understand by decoupling capacitor? Explain the capacitive shielding mechanism. [2+3]

9. What is fault tolerant system? Explain how careful design, testable functions and redundant architecture can avoid many failures in electronic circuits. [1+4]

10. Poor circuit layout and signal propagating principle may cause many problems in the circuit operation, manufacturing ease and probability of design errors. What factors will you consider while routing the signal traces on PCB. [5]

11. How does protyping model overcomes the short comings of waterfall model? Explain. [5]

12. What is wattmeter? Explain the working principle of induction wattmeter with diagram. [5]

13. Explain the existing system involved in your case study with the necessary block diagram. What was your recommendation over the existing system in terms of cost, manpower and plant automation? [8]

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32 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Sketch basic blocks of a generalized measurement system. Write function of each block. [6]

   b) Explain analog and digital modes of operation. Why digital instruments are becoming popular now? [4]

   c) An AC bridge circuit is working at 1000 Hz. Arm AB has 0.2 μF pure capacitance, arm BC has 500 Ω pure resistance, arm CD contains an unknown impedance and arm DA has 300 Ω resistance in parallel with 0.1 μF capacitor. Find the constant of arm CD considering it as a series circuit. [6]

2. a) What are the different parameters to define the static performance of an instrument? Distinguish between accuracy and precision of an instrument with a suitable example. [6]

   b) A strain gauge is bonded to a beam which is 12 cm long and has a cross sectional area of 3.8 cm^2. The unstrained resistance and gauge factor of the strain gauge are 220Ω and 2.2 respectively. On the application of load the resistance of the gauge changes by 0.015Ω. If the modulus of elasticity for steel is 207 GN/m^2, calculate [4]

   (i) the change in length of the steel beam
   (ii) the amount of force applied to the beam.

   c) Explain the working principle of a thermocouple for measuring temperature. State different laws associated with it. [6]

3. a) Explain the principles of operation of capacitive sensor. Also explain how linear relation between output and input can be obtained when capacitive sensor works on the principle of change in separation distance. [6]

   b) Explain the features of instrumentation amplifier and derive the expression for its Gain. [6]

   c) State and explain sampling theorem. [4]

4. a) A 6 bit DAC has a reference voltage of 11 volts if it uses

   (i) R-2R ladder network.
   (ii) Weighted resistive network.
   Find the minimum value of resistance in both cases such that the output current does not exceed 10mA. [4]

   b) What are the drawbacks of weighted resistor network? With suitable diagram explain the R-2R ladder digital to analog converter. [6]

   c) What is the purpose of using a S/H circuit in A/D conversion system. Explain its operation along with basic circuit and characteristic waveform. [6]

5. a) Describe the construction and working principle of a single phase induction type energy meter. Show that the total number of revolution made by disc during particular time is proportional to the energy consumed. [8]

   b) Explain the working principle of instrument transformer. Also explain why the secondary winding of current transformer should never be kept open circuited while primary is energized? [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject:* - Instrumentation I *(EE552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you understand by an instrumentation system, explain the function of each of its component with the help of a block diagram? [6]

   b) The wire in a strain gauge is 0.1 m long and has an initial resistance of 120Ω. On application of a force the wire length increases by 0.1 mm and resistance increases by 0.21Ω, determine the gauge factor of the device. [4]

   c) How do you define error in a measurement system? How the Gaussian curves can be used to explain the normal distribution of random errors in a measurement. Also state the properties of the curve. [6]

2. a) Explain how magnitude and direction of displacement can be measured with the help of inductive sensor. [6]

   b) What do you mean by piezoelectric effect? Explain how this effect can be the design basis of piezoelectric pressure transducer. Define voltage sensitivity and charge sensitivity. Give its equivalent circuit and derive the expression for the output voltage by making suitable assumptions. [6]

   c) A linear resistance potentiometer is 50 mm long and is uniformly wound with a wire of total resistance 5000Ω. Under normal conditions, the slider is at the centre of the potentiometer. Determine the linear displacement when the resistance of the pot as measured by a wheatstone bridge is 1850 Ω. If it is possible to measure a minimum value of 5 Ω resistence with the above arrangement determine the resolution of the pot in mm. [4]

3. a) Why signal conditioning is done in instrumentation system? Derive the expression for closed loop gain of op-amp in inverting mode. Also explain ideal characteristics of operational amplifier. [6]

   b) Design an integrator circuit which will produce a ramp voltage of -20 V/msec. [4]

   c) Draw the block diagram of optical fiber communication system and write advantages of it. [6]

4. a) Explain how analog to digital conversion is achieved by using Dual Ramp ADC. [6]

   b) Explain the operation of sample and hold circuit. Also explain aperture time and acquisition time of the circuit. [6]

   c) What will be a 4-bit successive approximation digital output for an analog input of 4.287V if full range of converter (ER) is 5V? [4]

5. a) What is wattmeter? Write is types. Explain the wattmeter which can measure ac as well as dc power with the help of construction and working principle. [8]

   b) What is data acquisition system? Explain the function of different component of digital data acquisition system. [8]

32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is an instrumentation system? Explain its different components with the help of a block diagram. [6]

   b) What is random error? Which method do you think is the most appropriate to find its distribution among a given set of data, make a complete analysis and hence define probable error. [6]

   c) The output of an LVDT is connected to a 5V voltmeter through an amplifier whose amplification factor is 250. An output of 2 m V appears across the terminals of LVDT when core moves through a distance of 0.5 mm. calculate the sensitivity of LVDT and that of whole set-up. The milli-voltmeter scale has 100 divisions. The scale can be reads to 1/5 of divisions. Calculate the resolution of the instrument in mm. [4]

2. a) Explain the principle of operation of an inductive transducer used for the measurement of linear displacement. Why differential arrangement of such a transducer is required? [8]

   b) "Maxwell's bridge is not suitable for the measurement of high Q-coils", verify the statement and draw and explain the modified bridge which can measure the inductance of high Q-coils. [8]

3. a) Explain the construction and working of a megger used for the measurement of high resistance. [4]

   b) Describe how digital to analog conversion is achieved by using the R-2R ladder network. How this DAC over comes the limitations of WRN type of DAC? [8]

   c) An analog to digital converter having an input of (0-8)V is able to distinguish a change of 10.3 mv in its input signal, calculate: [4]

      i) The number of bits
      ii) What voltage change does each LSB represent
      iii) What voltage does IMSB represent

4. a) Explain the working principle of dy-nanometer type, wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

   b) What do you understand by a Data Acquisition system? Explain with a neat sketch, the role of multiplexer in a DAS. [8]

5. a) What do you understand by sample and hold circuit. Explain its functioning with the help of circuit diagram. [6]

   b) Explain the working and application of OP-amp as [6]

      i) an integrator
      ii) a differentiator and
      iii) a substractor

   c) A piezoelectric pressure transducer having unknown charge sensitivity is connected to a charge amplifier, the gain being set to 5 mv/PC. The amplifier output is connected to an ultraviolet chart recorder, whose sensitivity is set to 25 mm/volt. Determine the sensitivity of the piezoelectric transducer if deflection of chart recorder is 100 mm

B.C.T II / II

32 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *__All__ questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Distinguish between static and dynamic characteristic of a measurement system. Define the various parameter used to study these characteristics.

   b How an unknown inductance can be measured from Maxwell's Bridge circuit and Hay's Bridge circuit. Why these different bridge circuits are used for measurement of unknown inductance instead of using single Bridge circuit, Explain.

2. a) Define transducer with example. Explain the working principle of strain gauge and derive the expression for the gauge factor.

   b) A barium titanate pickup has the dimensions of 5mm×5mm×1.25mm. The force acting on it is 5N. The charge sensitivity of barium titanate is 150pC/N and its permittivity is 12.5×10^{-9} F/m. if the modulus of elasticity of barium titanate is 12×10^{6}N/m^2, calculate the strain. Also calculate the charge and the capacitance.

3. a) Explain ideal characteristics of operation amplifier. Also explain different application of operational amplifier in measurement system.

   b) Explain how data can be transferred by Optical Fiber Cable and write advantages of optical fiber communication.

4. a) What are the advantages of inverted R-2R DAC over others DAC? Derive its output expression for R-2R DAC.

   b) What will be 6 bit successive approximation digital output of the analog input 6.127 V if V_R is 8V?

5. a) Explain the operating principle of electrical resonance type frequency meter in detail.

   b) Show how the instrument transformers are used to measure high voltage and current. And also explain why the secondary of current transformer should not be kept open circuited while primary is energized.

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2073 Bhadra

Exam.		**Regular**	
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Point out the difference between analog and digital measurement system. Explain the functional elements of an Instrumentation system with block diagram. [6]

   b) Explain different types of errors in measurement with their remedies. [6]

   c) A capacitive transducer uses two quartz diaphragm of area 600 mm^2 separated by a distance of 2.5 mm. A pressure of 8×10^5 N/m^2, when applied to the top diaphragm causes a deflection of 0.5 mm. The capacitance is 400×10^{-12} F when no pressure is applied to the diaphragm. Determine the value of capacitance after the application of 8×10^5 N/m^2. [4]

2. a) Explain how can the response of capacitive transducer, which works on the principle of variation of capacitance with displacement between two plates, be made linear. Also give the sensitivity of such an arrangement. [6]

   b) Show that Hay's Bridge can be used to measure the value of unknown inductance of a coil having high quality factor. [6]

   c) Determine the thermo electric sensitivity and emf developed in a thermocouple made of copper and ~~constantan~~ for a temperature of 50°C between its junction. Given that thermo electric emf of copper and constantan against platinum are 7.4μv/°C and -34.4 μv/°C respectively. [4]

3. a) Derive voltage gain of 3 Op-Amp Instrumentation amplifiers. Write the advantages of fiber optical communication. [6]

   b) Explain how A/D conversion can be achieved by using dual slope analog to digital converter. [6]

   c) The basic step of a 9 bit DAC is 10.3 mV (000000000) represents 0V, what O/P is produced if the input is (101101111)? [4]

4. a) Describe the constructional details and working of a ferro dynamic type of frequency meter for the measurement of frequency. [8]

   b) Draw the block diagram of Digital Data Acquisition System (DAS). Explain each block briefly. Differentiate analog DAS and digital DAS in terms of their scope. [6+2]

5. a) Explain the requirement of a sample and hold circuit. Explain its operation and discuss its characteristic waveform to illustrate its specifications. [8]

   b) Explain ideal characteristics of operational amplifier. Also explain different application of operational amplifier in measurement system. [8]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt All questions.*
✓ *All questions carry equal marks.*
✓ *Assume suitable data if necessary.*

1. a) Discuss different errors in measurement system and the methods to minimize them. [8]

   b) Differentiate between analog and digital measurement system. [4]

   c) A voltmeter whose accuracy is 2% of the full scale reading is used on its 0-50V scale. It is used to measure a voltage of 15 V and 42 V. Calculate the possible error of both readings. Comment on your answer. [4]

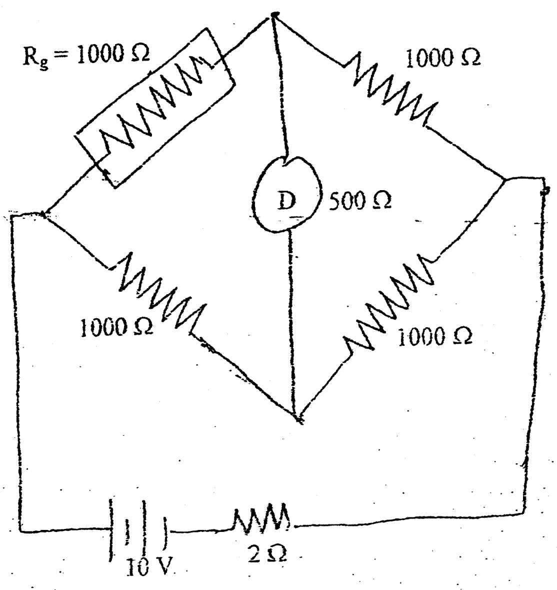
2. a) What is piezoelectric transducer? Define the voltage sensitivity and charge sensitivity. Give the equivalent circuit for piezoelectric transducer. Derive the expression for the output voltage by making suitable assumptions. [6]

   b) A capacitive transducer is made up of two concentric cylindrical electrodes. The length of electrodes is 0.025 m, the inner diameter of the outer cylindrical electrode is4.2 mm and the outer diameter of inner cylindrical electrode is 4.0 mm. Assume air medium. Determine the change in capacitance for a displacement of the inner electrode of 0.0025 m. Determine also the electric stress when a voltage of 150 V is applied across the electrodes. [4]

   c) What is Linear variable differential transformer (LVDT). Point out its merits and demerits. [6]

3. a) Explain the loading effect on a potentiometer and explain the effect of load resistance on the Linearity of the potentiometer. Also show that the error occurs at the mid-point of the potentiometer. [8]

   b) A strain gauge is connected in the bridge circuit shown in figure below. Find the deflection in the detector for a applied strain of 0.5%, if the detector has a sensitivity of 10 mm/μA and an internal resistance is 500 Ω. The guage factor of strain guage is 2. [8]



4. a) Describe at least two methods of analog to digital conversion. [8]

   b) Derive maximum allowable rate of change of input and maximum allowable frequency to the n bit ADC. [4]

   c) The basic step of a 9 bit DAC is 10.3 mV. If (000000000) represent OV, what output is produced if the input is (101101111)? [4]

5. a) What is meant by sampling? Define the terms analog signal, discrete signal, discrete pulse in instrumentation system. Discuss data acquisition system in brief. [8]

   b) Describe the construction and working principle of a single phase induction type energy meter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed. [8]

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B.C.T
II/II

32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt **All** questions.*
✓ *The figures in the margin indicate **Full Marks**.*
✓ *Assume suitable data if necessary.*

1. a) What do you understand by an instrumentation system? Explain the different components the system possesses, in detail. [8]

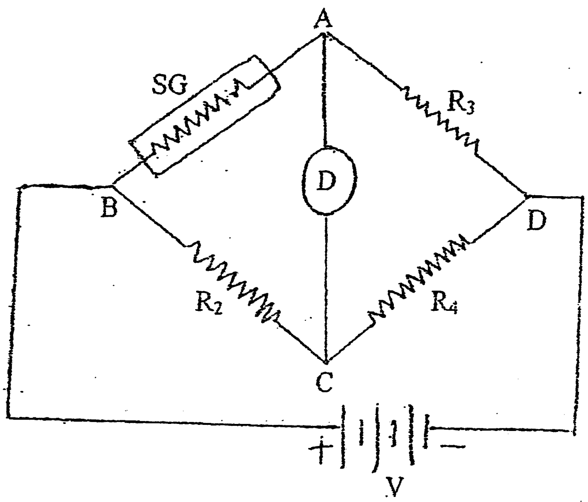
   b) What are the different parameters to define the static characteristics of an instrumentation system, explain establish a co-relation between linearity and sensitivity of an instrument with suitable example. [8]

2. a) Explain how the non-linear characteristics of a capacitive transducer, used for the measurement of displacement using the principle of change in capacitance due to change in distance between plates can be made linear. [8]

   b) Obtain the balance equation for an ac bridge and explain with diagram how Schering bridge can be used to measure unknown capacitance. [8]

3. a) Explain how flow rate of conducting fluid can be measured by using electromagnetic flow meter. Also explain disadvantage of d.c. excition used in it. [8]

   b) A strain gauge of resistance 200Ω and gauge factor 2 is connected in the arm AB of the bridge as shown below. [8]



The resistance of arms CD and DA are 100Ω each. R_2 is adjusted for balance under unstrained condition. The supply voltage to the bridge is 10V connected across BD. Determine the output voltage when a detector of infinite resistance is connected across output terminals and strain is of 500μ strain. Determine the current flowing through the detector for the same strain if resistance of detector is 250Ω.

4. a) State and explain sampling theorem. What is "aliasing" and how can it be avoided? [8]

   b) Explain how A/D conversion can be achieved by using dual slope analog to digital analog. [8]

5. a) Explain the method of D/A conversion using R-2R ladder network. Why do we prefer to use this DAC instead of WRN type, explain. [8]

   b) Explain the working principle of dynamometer type wattmeter and also prove that the deflection torque is directly proportion to power consumed by the load in both a.c. and d.c. circuit. [8]

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35 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt **All** questions.*
✓ *The figures in the margin indicate **Full Marks**.*
✓ *Assume suitable data if necessary.*

1. a) Discuss the analog and digital measurement system with the help of their respective block diagrams. [6]

   b) An ac bridge circuit is working at 1000 Hz. Arm AB has 0.2 μF pure capacitance, arm BC has 500 Ω pure resistance, arm CD contains an unknown impedance and arm DA has 300 Ω resistance in parallel with 0.1 μF capacitor. Find the constant of arm CD considering it as a series circuit. [10]

2. a) What is loading effect of a potentiometer? Show that the error will be maximum when the slider of the potentiometer is at midpoint of the potentiometer. [8]

   b) Determine the thermoelectric sensitivity and emf developed in a thermocouple made of copper and constantan for a temperature of 50°C between its junction. Given that thermo electric emf of copper and constantan against platenium are 7.4 μV/°C and –34.4 μV/°C respectively. [4]

   c) Explain how the flow of fluid can be measured by using Hot Wire Anemometers. [4]

3. a) Prove that "Linear relationship between capacitance and separation distance between two plates can be achieved by using differential arrangement". [8]

   b) Describe the construction and working of linear variable differential transformer for the measurement of displacement. [8]

4. a) Show how can an R-2R ladder network be used to generate a binary weighted sequence of current. [6]

   b) Highlight the advantages of optical fiber transmission over conventional data transmission system. [4]

   c) What is an instrumentation amplifier? Derive the expression for its gain. [6]

5. a) Explain the constructional detail and operating principle of a single phase induction type energy meter. [8]

   b) A 3-bit DAC has a voltage range of (0 - 12) V. Calculate the [8]

      i) weight of LSB
      ii) weight of MSB
      iii) exact range of the converter
      iv) percentage error

      If now, the bit of the converter is increased to 6, show by how much amount the error is increased or decreased? Justify your answer.

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

Exam.	Regular		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

Subject: - Instrumentation I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain different component of measurement system with suitable examples. [4]

   b) A balanced AC bridge has the following constants [6]

   arm AB: $R = 1000\ \Omega$ in parallel with $C = 0.5\ \mu F$
   arm BC: $R = 1000\ \Omega$ in series with $C = 0.5\ \mu F$
   arm CD: $R = 200\ \Omega$ in series with $L = 30$ mH

   Find the constant of arm CD. Express the result as a pure R in parallel with pure C or L.

   c) Using statistical analysis of random error of data measurement, explain how probable error in measurement can be obtained. [6]

2. a) Explain how can the response of capacitive transducer, which works on the principle of variation of capacitance with displacement between two plates, be made linear. Also give the sensitivity of such an arrangement. [6]

   b) Explain ideal characteristics of operation amplifier. Also explain different application of operational amplifier in measurement system. [6]

   c) A piezo-electric pressure transducer having sensitivity of 4×10^{-12} C/N is connected to a charge amplifier, the gain being set to 10 mV/pc. The amplifier output is connected to a ultra-violet chart recorder whose sensitivity is set in such a way that the deflection of the chart recorder due to a force of 400 N is 100 mm. Find the overall sensitivity of the device and the sensitivity of the chart recorder. [4]

3. a) Explain how analog to digital conversion can be obtained by using flash ADC. [6]

   b) State and explain Nyquist criterion. Also explain the phenomenon of aliasing and the way to eliminate it. [4+2]

   c) Consider a 6-bit digital to analog converter with a resistance of 20 KΩ in MSB position. The converter is designed with weighted resistive network. The reference voltage is 12 V. The output of the resistive network is connected to an operational amplifier with a feedback resistance of 10 KΩ. What is the analog output for a binary input of 101011? [4]

4. a) Describe the construction and working of a single phase induction type energy meter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed. [8]

   b) Show how the instrument transformers are used to measure high voltage and current. [4]

   c) The basic step of a 9 bit DAC is 10.3 mV. If (000000000) represents 0 V, what O/P is produce if the input is (101101111)? Write the advantages of R-2R ladder type DAC over WRN type. [2+2]

5. a) List out different types of frequency meter. Explain the constructional detail and working principle of any one of them to measure frequency. [8]

   b) What do you understand by communication of data in an instrumentation system? Explain the principle of optical fibre data communication system and highlight its advantages over conventional data communication system. [8]

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22 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Draw the functional block diagram of an instrumentation system. Explain each block briefly. [6]

   b) Explain how inductance of a coil can be measured using Hay's Bridge. Also explain why this bridge is suitable for the measurement of inductance of coil having high quality factor. [6]

   c) Show how the capacitor transducer can be used to measure the liquid level. [4]

2. a) What is an electrical transducer? How can it be classified? Also explain how direction and magnitude of displacement can be measured with Linear variable differential transformer [LVDT]. [6]

   b) In order to measure the strain in a cantilever beam a single strain guage of resistance 1000 Ω and gauge factor 2 is mounted on the beam and connected to arm AB of the bridge circuit. The other arms BC, CD and DA of the bridge have a resistance of 1000 Ω each. A d.c. voltage of 10 V is applied to terminal AC. Find: [6]
      i) The output voltage across terminal BD for 0.1 percent strain.
      ii) The output voltage across BD for the same strain if a voltmeter having internal resistance 2000 Ω is connected across BD.

   c) An operation amplifier is used as in integrator to produce a ramp signal of -10 V/ms. Design the circuit for this. [4]

3. a) Explain the loading effect on the accuracy of a resistance potentiometer transducer when used for the measurement of displacement. Also show that maximum error occurs at the mid-point of the potentiometer. [6]

   b) Explain the purpose and operation of Dual slope ADC with necessary figures. [6]

   c) What is a Data Acquisition system? Draw the block diagram of Digital Data Acquisition System. Explain its operation. [4]

4. a) How can ac power be measured using dynamometer type wattmeter? Explain with the help if its construction and operation in detail. [8]

   b) Explain the purpose of using instrument transformers in measurement. [4]

   c) An analog voltage signal whose highest significant frequency is 1 KHZ is to be digitally coded with a resolution of 0.01% covering a voltage range of 0-10 V. Determine: [4]
      i) Minimum number of bits in the digital code
      ii) Analog value of LSB
      iii) Minimum sampling rate
      iv) Aperture time required for the A/D converter

5. a) Explain the purpose and use of S/H circuit with necessary circuit diagrams. Discuss its various characteristics with the help of waveform associated. [6]

   b) Define precision and resolution in measurement. Explain the working principle of Megger. [6]

   c) Draw the block diagram of optical communication system. Briefly explain each block. [4]

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INSTITUTE OF ENGINEERING

Examination Control Division

2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I ***(EE552)***

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Distinguish between analog and digital system of measurement. [6]

   b) A 0-150V voltmeter has guaranteed accuracy of 1% of full scale reading. The volt measured by this instrument is 75V and 37.5V. Calculate the possible percentage error of both readings. Comment upon the result. [4]

   c) A balanced AC bridge has the following constants: [6]
   arm AB, $R = 2000\Omega$ in parallel with $C = 0.047\mu F$
   arm BC, $R = 1000\Omega$ in series with $C = 0.47\mu F$
   arm CD, unknown R
   arm DA, $C = 0.5\mu F$

   The frequency of oscillator is 1000Hz. Find the constant of arm CD.

2. a) Obtain the balance equation for Hay's bridge and explain why it is most suitable for the measurement of inductance of a coil having high quality factor. [6]

   b) Show how "Loading effect" causes a non linear relationship between the input and output in a measurement made by a potentiometer. Also prove that the maximum error occurs at the mid-point of the pot wire. [6]

   c) A capacitive transducer is made up of two concentric cylindrical electrodes. The outer diameter of the inner electrode is 4mm and the dielectric medium is air. The inner diameter of the outer electrode is 4.1mm. Calculate the dielectric stress when a voltage of 100V is applied across the electrode. Is it within safe limit? The length of electrode is 20mm. Calculate the change in capacitance if the electrode is moved through a distance of 2mm. [4]

3. a) Describe the circuit of 3 amplifier configuration of an instrumentation amplifier. Also derive the expression for output voltage in terms of two input voltage. [6]

   b) In order to measure the strain in a cantilever beam, a single strain gauge of resistance $2K\Omega$ and gauge factor 2 is mounted on the beam and connected to one arm of the bridge circuit. The other arms of the bridge have a resistance of $2K\Omega$ each. Calculate the detector deflection for 1000 micro-strain if the detector 0sensitivity is $10mm/\mu A$ and its internal resistance is: (i) 100Ω (ii) 200Ω. the supply to the bridge is 10V. [4]

   c) Explain how digital to analog conversion can be achieved by using R-2R ladder network DAC. Discuss its advantages over WRN type of DAC. [6]

4. a) Describe in detail the successive approximation method of analog to digital (A/D) conversion taking an example of 4-bit converter having full range of 5V and input of 3.215V. [6]

   b) An 11-bit ADC has conversion time of 20μS and full scale voltage of 10V. Find the maximum rate of change of input signal and maximum input frequency that the analog input signal may have in order that the converter can resolve the input signal into 11-bit number in a signal conversion. [4]

   c) What is data acquisition system? Explain the function and objective of each component of an analog data acquisition system. [6]

5. a) Explain the construction and working principle of a single phase electro-dynamometer type of wattmeter and derive the expression of deflection for both ac and dc operation. [8]

   b) What do you understand by sample and hold circuit. Explain its functioning with the help of circuit diagram and also discuss about its characteristics to define its specification. [8]

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4. a) Define piezo-resistive effect and gauge factor of a resistance strain gauge and derive the expression for the gauge factor. [10]

   b) A barium titanate piezo-electric pick-up has dimensions of 12mm×12mm×3mm and a voltage sensitivity of 0.015 Vm/N. Relative permittivity of barium titanate is 1400 and modulus of elasticity of barium titanate is 10×10^{10} N/m^2. If the force applied is 20N, determine (i) the output voltage (ii) charge sensitivity (iii) strain (iv) charge generated (v) the capacitance of the pick up. [6]

5. a) Explain different applications of operational amplifier in measurement system. Also show that if a d.c. voltage is applied to an integrator it will produce a ramp voltage. [8]

   b) A 6-bit DAC has 20 KΩ resistance in MSB position. The converter is designed with weighted resistive network. The reference voltage is 12V. The output of the resistive network is connected to an operation amplifier with a feedback resistance of 5KΩ. What will be analog output for a binary input of 101101? [8]

6. a) Describe the construction details and working of a single phase electro-dynamometer type of wattmeter. Also derive the expression for deflection for ac operation. [10]

   b) A 10 bit, 10V successive approximation ADC has 20μS conversion time. Find the maximum rate of change of input signal and maximum input frequency. [6]

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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any Five questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Define static and dynamic characteristics of a measurement system and explain the terms – accuracy, sensitivity and resolution with refer to indicating instruments. [8]

   b) Define probable errors and explain how are they analysed statistically. [8]

2. a) Describe how Schering bridge can be used for measurement of an unknown capacitance. Derive the condition for balance. [10]

   b) A moving coil voltmeter has a uniform scale with 100 divisions and gives full scale reading of 200V. The instrument can read upto $1/5^{th}$ of a scale division with fair degree of certainty. Determine the resolution of the instrument in volts. [6]

3. a) What is a piezo-electric transducer? Give its equivalent circuit. Derive an expression for the output voltage by making suitable simplifying assumptions. [8]

   b) A strain guage having a resistance of 800Ω and a guage factor 5 is bonded on to a member of a structures under tensile stress. Determine the percentage strain suffered by the member if the change in the resistance of the guage is accurately measured as 2.4Ω. [8]

4. a) Explain the effect of the input resistance of the output device on the output voltage of a potentiometer. Also show that linearity and sensitivity of a potentiometer are two conflicting requirement. [8]

   b) A poteniometer has a resistance of 1000Ω and is related as 5W. What is the maximum allowable excitation voltage? Calculate the sensitivity and resolution if the length of poteniometer is 0.5m and there are 500 turns. Also calculate percentage loading error at 0.87 of the travel if a voltmeter of 5000Ω is connected across the potentiometer. [8]

5. a) Explain briefly how digital to analog conversion can be achieved by weighted resistor network DAC. [8]

   b) An 8-bit DAC has reference voltage of 10V. It uses R-2R ladder network. Find the minimum value of resistance R such that the analog output voltage of operational amplifier having feedback resistance 10KΩ does not exceed 9.5V. [8]

6. a) Describe the construction and working of a single phase induction type energy meter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed. [10]

   b) What is data-acquisition system? Explain different components of digital data acquisition system. [6]

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Examination Control Division
2069 Poush

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Instrumentation I *(EE 552)*

✓ Candidates are required to give their answers in their own words as far as practicable.
✓ *Attempt **All** questions.*
✓ *The figures in the margin indicate **Full Marks**.*
✓ *Assume suitable data if necessary.*

1. a) Explain the function of different components of a measurement system with example. [6]

   b) Explain the construction and working principle of a linear variable differential transformer. [6]

   c) Obtain the balanced condition for Schering's Bridge and Also explain how this can be used to measure unknown capacitance. [4]

2. a) What is piezo-electric transducer? What are the materials used in such transducer? Also derive the expression for the out-put voltage developed due to applied force. [6]

   b) A piezo-electric pressure transducer having unknown sensitivity is connected to a charge amplifier, the gain being set to 10mV/pc. The amplifier output is connected to a ultraviolet chart recorder, whose sensitivity is set to 50 mm/V. Determine the sensitivity of piezo-electric pressure transducer if a deflection of 100 mm occurs in the chart recorder due to a force of 200N applied to the piezo-electric pressure transducer. [4]

   c) What are the characteristics of an ideal operational amplifier? Derive the expression for close loop gain of operational amplifier in inverting and non-inverting mode. [6]

3. a) Explain the principle of operation of capacitive displacement transducers. Also explain how can the response of the capacitive transducer, which works on the principle of variation of capacitance with the displacement between two plates, be made linear. Also give the sensitivity of such arrangement. [6]

   b) A voltage dividing potentiometer is used to measure an angular displacement. The angle of displacement is 120° and total angle of travel is 355°. Calculate the voltage out-put on open circuit if the potentiometer is excited by 120V source. Calculate the actual value of the out-put voltage at this setting of a voltmeter of 2 MΩ is connected across the output. The resistance of the potentiometer is 2 kΩ. Also calculate the percentage error. [4]

   c) State and explain sampling theorem in digital instrumentation system. [6]

4. a) Explain the special feature of instrumentation amplifier and also derive the expression for its gain. [6]

   b) Describe with the help of block diagram and flowchart, the method of conversion of analog signal to digital using successive approximation ADC. [6]

   c) An analog voltage signal whose highest significant frequency is 1 KHZ is to be digitally coded with a resolution of 0.01% covering a voltage range of 0-10V. Determine: (i) Minimum number of bits in the digital code (ii) Analog value of LSB (iii) Minimum sampling rate (iv) Aperture time required for the [4]

5. a) Explain the features and working principle of sample and hold circuit. [6]

   b) Mention the different types of energy meter. Also show that the deflection torque is directly proportional to the power consumed by the load. [6]

   c) What is data acquisition system? Also explain different component of digital data acquisition system. [4]

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Exam.	Regular		
Level	BE	**Full Marks**	80
Programme	BEL, BEX, BCT	**Pass Marks**	32
Year / Part	II / II	**Time**	3 hrs.

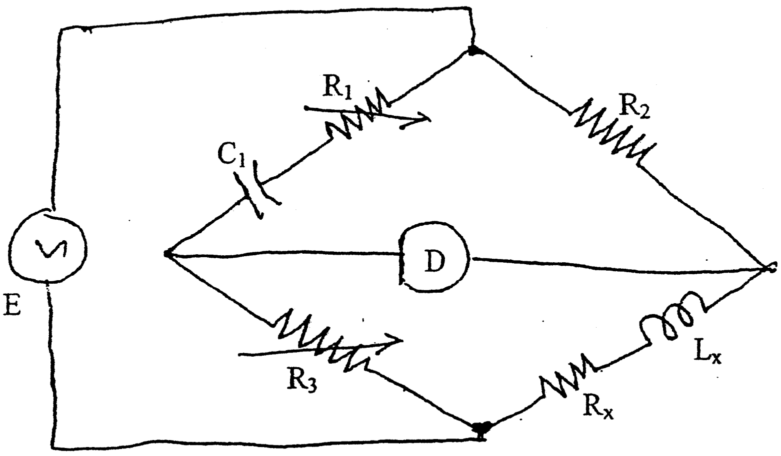
Subject: - Instrumentation I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any __Five__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Define measurement and measurement system. Also explain various types of errors encountered in electrical measurement. [8]

   b) The value of power consumed was determined by measuring current "I" flowing through the resistance with an error of ±1.5 percent and resistance "R" with an error of ±1 percent. Determine the maximum possible relative error to be expected on measuring power "P" from formula $P = I^2R$. [8]

2. a) The AC bridge shown in the figure is used to measure the unknown induction (L_x) of a coil having quality factor greater than 10. Show that $L_x = R_2R_3C_1$, when the bridge is balanced. [8]



   b) Explain how low-resistance can be measured with the help of ammeter-voltmeter method. [8]

3. a) Explain the working principle of current transformer along with its connection in a circuit. What will happen if the secondary circuit of the current transformer is open circuited while the primary carries current? Explain. [8]

   b) The output of a potentiometer is to be read by a recorder of 10 KΩ input resistance. Non-linearity must be held to 1 percent. A family of poteniometers having a thermal rating of 5W and resistances ranging from 100Ω to 10,000Ω in 100Ω steps are available. Choose, from this family, the potentiometer that has the greatest possible sensitivity and meets other requirements. What is the sensitivity if the potentiometer are single turn (360°) unit? [8]