GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

Each question is of equal Marks (10 Marks)

Q.1	Find the Fourier Series for $f(x)=e^{-x}$ in the interval $0<x<2\pi$.
Q.2	Expand $f(x)=x\sin x$ as a Fourier series in the interval $0<x<2\pi$.
Q.3	Find the Fourier series of $f(x)=2x-x^2$ in the interval (0,3). Hence deduce that $\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\ldots=\frac{\pi^2}{12}$.
Q.4	Find the Fourier series of the function $f(x)=\begin{cases} x^2 & 0\le x\le\pi \\ -x^2 & -\pi\le x\le 0\end{cases}$.
Q.5	Find the Fourier series of the function $f(x)=\begin{cases} \pi x & 0<x<1 \\ 0 & x=1 \\ \pi(x-2) & 1<x<2\end{cases}$. Hence show that $\frac{1}{1}-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\ldots=\frac{\pi}{4}$.
Q.6	Find the Fourier series of $f(x)=x^2$ in the interval $0<x<a$, $f(x+a)=f(x)$.
Q.7	If $f(x)=\lvert\cos x\rvert$, expand $f(x)$ as a Fourier series in the interval $(-\pi,\pi)$, $f(x+2\pi)=f(x)$.
Q.8	For the function $f(x)$ defined by $f(x)=\lvert x\rvert$, in the interval $(-\pi,\pi)$. Obtain the Fourier series. Deduce that $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots=\frac{\pi^2}{8}$.
Q.9	Given $f(x)=\begin{cases} -x+1 & -\pi\le x\le 0 \\ x+1 & 0\le x\le\pi\end{cases}$. Is the function even of odd ? Find the Fourier series for $f(x)$ and deduce the value of $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots$.
Q.10	Find the Fourier series of the periodic function $f(x)$; $f(x)=-k$ when $-\pi<x<0$ and $f(x)=k$ when $0<x<\pi$, and $f(x+2\pi)=f(x)$.
Q.11	Half range sine and cosine series of $f(x)=x(\pi-x)$ in $(0,\pi)$
Q.12	Find the Fourier series for the function $f(x)=\begin{cases} \pi x, 0<x<1 \\ \pi\left(x-2\right), 1<x<2\end{cases}$
Q.13	Find the Fourier series for f(x) defined by f(x) = $x+\frac{x^2}{4}$ when $-\pi< x <\pi$ and f(x + 2π) = f(x) and hence show that $\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\ldots\ldots=\frac{\pi^2}{12}$

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

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Q.14	Find the Fourier series for the function $f(x)=\begin{cases} x; 0<x<1 \\ 0; 1<x<2 \end{cases}$.
Q.15	If f(x) = x in $0 < x < \frac{\pi}{2}$ $= \pi - x$ in $\frac{\pi}{2} < x < \frac{3\pi}{2}$ $= x - 2\pi$ in $\frac{3\pi}{2} < x < 2\pi$ Prove that f(x) = $\frac{4}{\pi}\left\{\frac{\sin x}{1^2}-\frac{\sin 3x}{3^2}+\frac{\sin 5x}{5^2}-\right\}$
Q.16	If f(x) = $\frac{x}{l}$ when $0 < x < l$ $= \frac{2l-x}{l}$ when $l < x < 2l$ Prove that f(x) $\frac{1}{2}-\frac{4}{\pi^2}\left(\frac{1}{I^2}\cos\frac{\pi x}{l}+\frac{1}{3^2}\cos\frac{3\pi x}{l}+\frac{1}{5^2}\cos\frac{5\pi x}{l}+.......\right)$
Q.17	When x lies between $\pm\pi$ and p is not an integer, prove that sin px = $\frac{2}{\pi}\sin p\pi\left(\frac{\sin x}{1^2-p^2}-\frac{2\sin 2x}{2^2-p^2}+\frac{3\sin 3x}{3^2-p^2}-.........\right)$
Q.18	Find the Fourier series for the function $f(x)=e^{ax}$ in $(-l,l)$
Q.19	Half range sine and cosine series of $f(x)=2x-1$ in $(0,1)$
Q.20	Half range sine and cosine series of x^2 in $(0,\pi)$
Q.21	Find Half range sine and cosine series for $f\left(x\right)=(x-1)^2$ in $\left(0,1\right)$
Q.22	Attempt the following.

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	If $A=\begin{bmatrix}1 & 2 & -2\\ -1 & 3 & 0\\ 0 & -2 & 1\end{bmatrix}$ find A^3 and A^{-1} using Cayley Hamilton Theorem. Show that the matrix $\frac{1}{\sqrt{3}}\begin{bmatrix}1 & 1+i\\ 1-i & -1\end{bmatrix}$ is unitary.
Q.23	Attempt the following. Using Cayley-Hamilton theorem, find the inverse of $\begin{bmatrix}5 & 3\\ 3 & 2\end{bmatrix}$. If A = $\begin{bmatrix}3 & 1\\ -1 & 2\end{bmatrix}$ show that $A^2-5A+7I=0$, Where I is a unit matrix of second order.
Q.24	Attempt the following. Define Hermitian matrix. If $A=\begin{bmatrix}2+i & 3 & -1+3i\\ -5 & i & 4-2i\end{bmatrix}$ show that AA^* is a Hermitian matrix. Using Gauss –Jordan Method , find the inverse of $\begin{bmatrix}2 & 1 & 2\\ 2 & 2 & 1\\ 1 & 2 & 2\end{bmatrix}$.
Q.25	Find the eigenvalues & eigenvectors of the following matrix $A=\begin{bmatrix}2 & 2 & 1\\ 1 & 3 & 1\\ 1 & 2 & 2\end{bmatrix}$.

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

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Q.26	Find the eigenvalues & eigenvectors of the following matrix $A=\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$.
Q.27	Attempt the following. Find A^{-1} by Gauss Jordan Method, where $A=\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$. Find characteristic equation ,eigen value and eigen vectors of matrix A ifA= $\begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{bmatrix}$.
Q.28	If $A=\begin{bmatrix} 1 & 0 & 3 \\ 2 & 1 & -1 \\ 1 & -1 & 1 \end{bmatrix}$ find A^{-1} using Cayley Hamilton Theorem.
Q.29	If $A=\begin{bmatrix} 1 & 1 & 2 \\ 0 & -2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ find A^{-1} using Cayley Hamilton Theorem.
Q.30	Verify cayley-Hamilton theorem for the matrix A, where $A=\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

Each question is of equal Marks (10 Marks)

Q.31	Verify cayley-Hamilton theorem for the matrix A, where $A=\begin{bmatrix} 7 & 2 & -2 \\ -6 & -1 & 2 \\ 6 & 2 & -1 \end{bmatrix}$
Q.32	Verify cayley-Hamilton theorem for the matrix A, where $A=\begin{bmatrix} 3 & 2 & 4 \\ 4 & 3 & 2 \\ 2 & 4 & 3 \end{bmatrix}$
Q.33	Find the eigen values and eigen vectors of the matrix $A=\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$
Q.34	Find the eigen values and eigen vectors of the matrix $A=\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$
Q.35	Find the eigen values and eigen vectors of the matrix $A=\begin{bmatrix} 2 & 1 & -1 \\ 1 & 1 & -2 \\ -1 & -2 & 1 \end{bmatrix}$
Q.36	Attempt the following. Prove that the matrix $A=\begin{bmatrix} \frac{1}{2}(1+i) & \frac{1}{2}(-1+i) \\ \frac{1}{2}(1+i) & \frac{1}{2}(1-i) \end{bmatrix}$ ia unitary and find A^{-1}. Show that $A=\begin{bmatrix} 3 & 7-4i & -2+5i \\ 7+4i & -2 & 3+i \\ -2-5i & 3-i & 4 \end{bmatrix}$ is a Hermitian matrix.

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

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Q.37	Attempt the following. Show that the matrix $A=\begin{bmatrix}\alpha+i\gamma & -\beta+i\delta \\ \beta+i\delta & \alpha-i\gamma\end{bmatrix}$ is unitary matrix, if $\alpha^2+\beta^2+\gamma^2+\delta^2=1$.
Q.38	Show that every square matrix can be uniquely expressed as $P+iQ$, where P and Q are Hermitian matrices.
Q.39	Solve the following equations : (a) $(D-2)^2 y = 8(e^{2x} + \sin 2x + x^2)$ (b) $(D^2 + D) y = x^2 + 2x + 4$
Q.40	Solve the following equations : (a) $(D^2 + 1) y = x^2 \cos x$ (b) $(D^2+1)y = e^{2x} + \cosh 2x + x^3$
Q.41	Solve the following equations : (a) $(D^4+2D^2+1)y = x^2\cos^2 x$ (b) $(D^2 + 2) y = e^{-2x} + \cos 3x + x^2$
Q.42	Solve the following equations : (a) $(D^2 + 2D+1) y = x e^x \sin x$ (b) $(D^2 - 9) y = e^{3x} \cos 2x$
Q.43	Solve the following equations : (a) $(D-2)^2 y = 8(e^{2x} + \sin 2x + x^2)$ (b) $(D^3 + 8) y = x^4 + 2x + 1$
Q.44	Solve the following equations : (a) $(D^2 - 1) y = x \sin 3x + \cos x$ (b) $(D^2-4D+4)y = 2e^x + \cos 2x + x^3$
Q.45	Solve: $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 5y = x^2 \sin(\log x)$.
Q.46	Solve: $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + y = ((\log x)\sin(\log x)+1)/x$

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

Each question is of equal Marks (10 Marks)

Q.47	Solve: $(3x+2)\dfrac{d^2y}{dx^2}+3(3x+2)\dfrac{dy}{dx}-36y=3x^2+4x+1.$
Q.48	Solve: $x^2\dfrac{d^2y}{dx^2}-3x\dfrac{dy}{dx}+5y=x^2\sin(\log x).$
Q.49	Solve: $x^2\dfrac{d^2y}{dx^2}-2x\dfrac{dy}{dx}-4y=x^2+2\log x.$
Q.50	Solve by using method of variation of parameters: $\dfrac{d^2y}{dx^2}+y=\sec x.$
Q.51	Solve by using method of variation of parameters: $\dfrac{d^2y}{dx^2}+y=\tan x.$
Q.52	Solve by using method of variation of parameters: $\dfrac{d^2y}{dx^2}-2\dfrac{dy}{dx}=e^x\sin x$
Q.53	The charge q on a plate of a condenser C is given by $L\dfrac{d^2q}{dt^2}+R\dfrac{dq}{dt}+\dfrac{q}{c}=E\sin pt$ the circuit is tuned to resonance so that $p^2=\dfrac{1}{LC}$ if initially the current i and charge q be zero show that for small value of $\dfrac{R}{L}$,the current in the circuit at time t is given by $\left(\dfrac{Et}{2L}\right)\sin pt$.
Q.54	Solve the following simultaneous equations: $\begin{matrix} Dx+y=\sin t \\ Dy+x=\cos t \end{matrix}$; where D = $\dfrac{d}{dt}$ given that when t =0 ,x =1 and y = 0.
Q.55	Solve the following simultaneous equations: $\begin{matrix} Dx+y=e^t \\ Dy+x=e^{-t} \end{matrix}$; where D = $\dfrac{d}{dt}$

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

Each question is of equal Marks (10 Marks)

Q.56	Form the partial differential equation of following: (a) $2z=\frac{x^2}{a^2}+\frac{y^2}{b^2}$ (b) $z=f(x+ct)+g(x-ct)$
Q.57	Form the partial differential equation of following: (a) $2z=a^2x^2+b^2y^2$ (b) $z=x+y+f(xy)$
Q.58	Form the partial differential equation of following: (a) $z=(x^2+a)(y^2+b)$ (b) F(xy+z^2 , x + y+ z) = 0
Q.59	Solve following partial differential equations : (a) $x(y^2-z^2)p+y(z^2-x^2)q=z(x^2-y^2)$ (b) $x(y-z)p+y(z-x)q=z(x-y)$
Q.60	Solve following partial differential equations : (a) $py+qx=pq$ (b) $z=px+qy+2\sqrt{pq}$
Q.61	Solve following partial differential equations : (a) $\frac{\partial^2 z}{\partial x^2}-\frac{\partial^2 z}{\partial x\partial y}=\sin x\cos y+xy$ (b) $\frac{\partial^2 z}{\partial x^2}-\frac{\partial^2 z}{\partial x\partial y}=\cos x\cos 2y$
Q.62	Solve following partial differential equations : (a) $\frac{\partial^2 z}{\partial x^2}-2\frac{\partial^2 z}{\partial x\partial y}+\frac{\partial^2 z}{\partial y^2}=e^{x+4y}$ (b) $\frac{\partial^2 z}{\partial x^2}-2\frac{\partial^2 z}{\partial x\partial y}+\frac{\partial^2 z}{\partial y^2}=x^3+e^{x+2y}$
Q.63	(a) Solve: $\frac{\partial^2 z}{\partial x\partial y}=e^{-y}\cos x$,given that z = 0 when y = 0 and $\frac{\partial z}{\partial y}=0$ when x = 0 (b) Solve: $\frac{\partial^2 z}{\partial x^2}=z$ given that $z=e^y$ and $\frac{\partial z}{\partial x}=e^{-y}$ when *x = 0*
Q.64	Solve: $\frac{\partial z}{\partial x}=2\frac{\partial z}{\partial y}+z$ where z (x , 0) = 8 e^{-5x} using method of separation of variables.
Q.65	Solve: $3\frac{\partial z}{\partial x}+2\frac{\partial z}{\partial y}$ *= 0,* where *z (x , 0) = 4 e*$^{-x}$ by using method of separation of

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	variables.
Q.66	Solve: $\frac{\partial z}{\partial x} = 4\frac{\partial z}{\partial y}$ where z(0 , y) = 8 e^{-3y} using method of separation of variables.
Q.67	Find the series solution of the differential equation $x\frac{d^2y}{dx^2}+\frac{dy}{dx}+xy=0$
Q.68	Solve the following equation in power series $(1+x^2)\frac{d^2y}{dx^2}+x\frac{dy}{dx}-y=0$
Q.69	Solve in series in differential equation $\frac{d^2y}{dx^2}+xy=0$
Q.70	Solve in series in differential equation $x\frac{d^2y}{dx^2}+\frac{dy}{dx}-y=0$
Q.71	solve in series the differential equation $\frac{d^2y}{dx^2}+4y=0$
Q.72	Attempt the following 1) Derive Cauchy –Riemann equations for complex function w = f(z) in polar form. 2) Define harmonic function, Show that $u=\frac{1}{2}\log(x^2+y^2)$ is harmonic and determine its conjugate function.
Q.73	Attempt the following 1) Derive Cauchy-Rieman equation for a complex function $W = f(z)$ In polar form .Hence deduce that $\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}+\frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2}=0$. 2) If $w=u+iv$ represent the complex potential function for an electric field and $u=3x^2y-y^3$, determine the function v.
Q.74	Attempt the following 1) If f(z) is analytic function of z, prove that $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\lvert f(z)\rvert^2 = 4\lvert f'(z)\rvert^2$ 2) Evaluate $\int_0^{1+i}(x^2-iy)dz$ along the path $(i) y=x (ii) y=x^2$
Q.75	Attempt the following 1) Find the image of infinite strip $\frac{1}{4}\le y\le\frac{1}{2}$ under the transformation $w=\frac{1}{z}$ also show the region graphically.

GUJARAT UNIVERSITY
B.E. SEM – 3 (CE/IT)
Question Bank
Advance Maths

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	2) Define line integral .Evaluate $\int_0^{3+i} z^2 dz$ along (i) the line $y = \frac{x}{3}$; (ii) the parabola $x = 3y^2$
Q.76	Attempt the following 1) Define bilinear transformation, Show that the transformation $w = \frac{2z+3}{z-4}$ maps the circle onto the straight line $4u+3=0$ 2) State Cauchy integral theorem and Cauchy integral formula. Evaluate $\oint_c \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)} dz$, where $c : \lvert z \rvert = 3$
Q.77	Attempt the following 1) Determine the analytic function whose real part is $u = e^{-x}(x \sin y - y \cos x)$. 2) Find the Bi-linear transformation, which maps the points $z = -1, i, 1$ into the points $w = 1, i, -1$.
Q.78	Attempt the following 1) Find the Bi-linear transformation which maps the points $z = 1, i, -i$ into the Points $w = 0, 1, \infty$. 2) Use Cauchy's integral formula to evaluate $\int_C \frac{e^{2z}}{(z+1)^4} dz$, where *C* is the circle $\lvert z \rvert = 2$.
Q.79	Attempt the following 1) Prove that $f(z) = e^{2z}$ is analytic every in the plane and find its derivative. 2) Find the image of $\lvert z - 2i \rvert = 2$ under the mapping $w = \frac{1}{z}$
Q.80	Attempt the following 1) Evaluate $\int_{1-i}^{2+3i} (z^2 + z) dz$ along the line joining the points $(1,-1)$ *and* $(2,3)$. 2) Evaluate $\oint_C \frac{2z+1}{z^2+z} dz$; where C *is* $\lvert z \rvert = \frac{1}{2}$.
Q.81	Attempt the following 1) If $w = u + iv$ represent the complex potential function for an electric field and $u = 3x^2 y - y^3$, determine the function v.

Each question is of equal Marks (10 Marks)

	2) State the Residue theorem and evaluate $\oint_C \frac{2z+1}{(2z-1)^2}\,dz$, where C is the circle $\lvert z\rvert = 1$.
Q.82	Attempt the following 1) Prove that $f(z) = e^{2z}$ is analytic every in the plane and find its derivative. 2) Expand $f(z) = \frac{z}{(z+1)(z+2)}$ about $z = -2$.
Q.83	Attempt the following 1) Evaluate $\int_0^{3+i} z^2 dz$ along (i) the line $y = \frac{x}{3}$ (ii) the parabola $x = 3y^2$ 2) Find the image of the upper half plane under the transformation $w = \frac{z}{i-z}$.
Q.84	Attempt the following 1) Find the Bi-linear transformation which maps the points $z = 1, i, -i$ into the Points $w = 0, 1, \infty$. 2) Determine the analytic function whose real part is $y + e^x \cos y$.
Q.85	Attempt the following 1) Evaluate $\int_C \frac{z^2+1}{z(2z+1)}\,dz$ where C is $\lvert z\rvert = 1$. 2) Under the transformation $w = \frac{1}{z}$ find the image of $x^2 - y^2 = 1$.
Q.86	Attempt the following 1) Find the analytic function whose imaginary part is $e^x \sin y$ 2) Under the transformation $w = \frac{1}{z}$ find the image of $\lvert z - 2i\rvert = 2$.
Q.87	Attempt the following 1) Evaluate $\int_C \frac{z^2+1}{z(2z+1)}\,dz$ where C is $\lvert z\rvert = 1$. 2) Under the transformation, $w = \frac{1}{z}$ find the image of $x^2 - y^2 = 1$.
Q.88	Evaluate: (i) $\oint_c \frac{e^{2z}}{(z+1)^4}\,dz$; where $c : \lvert z\rvert = 4$

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	(ii) $\oint_c \frac{e^z}{(z+1)^4(z-2)}dz$; where $c:\|z-1\|=3$