INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**MATHEMATICAL TRANSFORM TECHNIQUES**
Course Code	:	**AHSB11**
Program	:	**B.Tech**
Semester	:	**II**
Branch	:	**Mechanical Engineering**
Section	:	**A & B**
Academic Year	:	**2019 – 2020**
Course Faculty	:	**Dr. S. Jagadha, Associate Professor**

OBJECTIVES:

I	Enrich the knowledge solving algebra and transcendental equations and understanding Laplace transforms.
II	Determine the unknown values of a function by interpolation and applying inverse Laplace transforms.
III	Fitting of a curve and determining the Fourier transform of a function.
IV	Solving the ordinary differential equations by numerical techniques.
V	Formulate to solve Partial differential equation

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
			MODULE-I			
1	What is the order of convergence in Bisection method?	The order of convergence in Bisection method is one or linear.	Remember	CO 1	CLO 1	AHSB11.01
2	What is the order of convergence in Newton-Raphson method?	The order of convergence Newton-Raphson method is two.	Remember	CO 1	CLO 1	AHSB11.01
3	State the other name of Bisection method in determining the real root of algebraic and transcendental equation.	Bisection method is also called as Bolzono method in solving the real root of algebraic and transcendental equation.	Remember	CO 1	CLO 1	AHSB11.01
4	State the most powerful and elegant method in determining the real root of algebraic and transcendental equation.	Newton-Raphson method is the powerful and elegant method in solving the real root of algebraic and transcendental equation.	Remember	CO 1	CLO 1	AHSB11.01

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5	Define the term Laplace transform	If f(t) be a given function which is defined for all positive values of t, if $F(s) = \int_0^\infty e^{-st} f(t)\,dt$ exists, then F(s) is called Laplace transform of f(t) and is denoted by L{f(t)}	Remember	CO 1	CLO 2	AHSB11.02
6	State linearity property of Laplace transform	If L{f(t)} = f(s) then L [$a\,f(t) + b\,g(t)$] = a L [f(t)] +b L [g(t)]	Understand	CO 1	CLO 2	AHSB11.02
7	State change of scale property of Laplace transform	If L{f(t)} = f(s) then L [$f(at)$] = $\frac{1}{a}$ f($\frac{s}{a}$)	Understand	CO 1	CLO 3	AHSB11.03
8	State Laplace transform of periodic functions	If L{f(t)} = f(s) and f(t) is a periodic function with period T then $L[f(t)] = \frac{1}{1-e^{-sT}} \int_0^T f(t) e^{-st} dt$	Understand	CO 1	CLO 6	AHSB11.06
9	When does a Laplace transform exists?	Laplace Transform exists the function is piece-wise continuous and of exponential order	Understand	CO 1	CLO 2	AHSB11.02
10	State the Laplace transform of unit impulse function	The Laplace transform of unit impulse function is e^{-as}	Understand	CO 1	CLO 2	AHSB11.02
11	Describe the use of studying the Laplace transforms?	Laplace Transformation is very much useful in obtaining solution of Linear D.E's(both Ordinary and Partial), Solution of system of simultaneous D.E's, Solutions of Integral equations, solutions of Linear Difference equations and in the evaluation of definite Integral.	Understand	CO 1	CLO 2	AHSB11.02
12	State Laplace transform of derivatives	If $f(t)$, $f'(t)$, $f''(t)$, …, $f^{(n-1)}(t)$ are continuous, and $f^{(n)}(t)$ is piecewise continuous, and all of them are exponential order functions, then L [$f^{(n)}(t)$]= $s^n F(s) - \sum_{i=1}^{n} s^{n-i} f^{(i-1)}(0)$	Understand	CO 1	CLO 4	AHSB11.04
13	State Laplace transform of integrals	If L{f(t)} = f(s) then $\Rightarrow \int_s^\infty \int_s^\infty \cdots \int_s^\infty F(s)\,ds\,ds \cdots ds = L\left[\frac{1}{t^n} f(t)\right]$	Understand	CO 1	CLO 4	AHSB11.04
14	Why Laplace transforms are so useful for solving linear differential equations?	Laplace transforms are so useful for solving linear differential equations because the Laplace transform of the n^{th} derivative $f^n(x)$ can be related to the transform of f(x) in a simple manner.	Understand	CO 1	CLO 2	AHSB11.02
15	In H(t-a) at what point unit step function is defined	At the point t = a	Understand	CO 1	CLO 2	AHSB11.02
	MODULE-II					
1	What is the symbol μ called as?	The symbol μ is called as Average or Mean operator	Remember	CO 2	CLO 7	AHSB11.07
2	What is the symbol E called as?	The symbol E is called as Shift operator	Remember	CO 2	CLO 7	AHSB11.07
3 4	Express the relation between E in terms of Δ.	The relation between E in terms of Δ is1+Δ	Remember	CO 2	CLO 7	AHSB11.07

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
5	Establish the relation between E and D.	The relation between E and D is $E = e^{hD}$	Remember	CO 2	CLO 7	AHSB11.07
6	Express ∇y_5 in terms of y_2, y_3, y_4 and y_5?	$\nabla y_5 = y_5 - 3y_4 - 3y_3 - y_2$	Understand	CO 2	CLO 8	AHSB11.08
7	Define the term Interpolation.	Interpolation is an estimation of a value within two known values in a sequence of values.	Remember	CO 2	CLO 7	AHSB11.07
8	Represent the range of p in Gauss-Forward interpolation formulae.	The range of p in Gauss-Forward interpolation formulae is $0 < P < 1$	Remember	CO 2	CLO 8	AHSB11.08
9	Represent the range of p in Gauss-Backward interpolation formulae.	The range of p in Gauss-Forward interpolation formulae is $-1 < P < 0$	Remember	CO 2	CLO 8	AHSB11.08
10	Mention the name of formulae is used for unequal interval of x values to obtain the desired value of y.	The name of formulae is used for unequal interval of x values to obtain the desired value of y is Lagrange's interpolation formulae	Remember	CO 2	CLO 8	AHSB11.08
11	Define Average or Mean operator.	$\mu y_r = \frac{1}{2}\left[y_{r+1/2} + y_{r-1/2}\right]$	Remember	CO 2	CLO 7	AHSB11.07
12	State Newton's forward interpolation formulae for equal length of intervals.	$y = y_0 + p\,\Delta y_0 + \frac{p(p-1)}{2!}\,\Delta^2 y_0 + \cdots + \frac{p(p-1)(p-2)\ldots(p-(n-1))}{n!}\,\Delta^n y_0$	Remember	CO 2	CLO 8	AHSB11.08
13	State Newton's backward interpolation formulae for equal length of intervals.	$y = y_0 + p\,\nabla y_n + \frac{p(p+1)}{2!}\,\nabla^2 y_n + \cdots + \frac{p(p+1)(p+2)\ldots(p+(n-1))}{n!}\,\nabla^n y_n$	Remember	CO 2	CLO 8	AHSB11.08
14	State Gauss's forward interpolation formulae for equal length of intervals.	$y = y_0 + p\,\Delta y_0 + \frac{p(p-1)}{2!}\,\Delta^2 y_{-1} + \frac{(p+1)p(p-1)}{3!}\,\Delta^3 y_{-1} + \cdots$	Remember	CO 2	CLO 8	AHSB11.08
15	State Gauss's forward interpolation formulae for equal length of intervals.	$y = y_0 + p\,\Delta y_{-1} + \frac{(p+1)p}{2!}\,\Delta^2 y_{-1} + \frac{(p+1)p(p-1)}{3!}\,\Delta^3 y_{-1} + \cdots$	Remember	CO 2	CLO 8	AHSB11.08
16	State Lagrange interpolation formulae for unequal length of intervals.	$y = f(x) = \frac{(x-x_1)(x-x_2)\ldots(x-x_n)}{(x_0-x_1)(x_0-x_2)\ldots(x_0-x_n)}.y_0 + \ldots + \frac{(x-x_1)(x-x_2)\ldots(x-x_n)}{(x_0-x_1)(x_0-x_2)\ldots(x_0-x_n)}.y_n$	Remember	CO 2	CLO 8	AHSB11.08
17	Express the value of $(n+1)^{th}$ order difference of a polynomial of n^{th} degree.	The value of $(n+1)^{th}$ order difference of a polynomial of n^{th} degree is always zero	Understand	CO 2	CLO 8	AHSB11.08
18	Define the term Inverse Laplace transform	The inverse transform, or inverse of L{f(t)} or F(s), is f(t) = L^{-1} {F(s)} where s is real or complex.	Remember	CO 2	CLO 9	AHSB11.09
19	State linearity property of Inverse Laplace transform	If L^{-1} {f(s)} = f(t) then L^{-1} [a f(s) + b g(s)] = a L^{-1} [f(s)] + b L^{-1} [g(s)]	Understand	CO 2	CLO 9	AHSB11.09
20	State change of scale property of Inverse Laplace transform	If L^{-1} {f(s)} = f(t) then L^{-1} {F(s – a)} = e^{at} f(t) = e^{at} L^{-1} {F(s)}	Understand	CO 2	CLO 9	AHSB11.09

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
21	State convolution theorem of Laplace transform	If L{f(t)} = f(s) then $L[\int_0^t f(\tau)g(t-\tau)d\tau] = F(s).G(s)$	Understand	CO 2	CLO 10	AHSB11.10
22	State Inverse shifting property of Inverse Laplace transform	If L{ua(t) f(t –a)}= e^{-as} L{f(t)} = e^{-as} F(s),then L^{-1} { e^{-as} F(s)} = ua(t) f(t –a)	Understand	CO 2	CLO 9	AHSB11.09
23	State convolution theorem of Inverse Laplace transform	If L{f *g} = L {f(t)}.L{g(t)} = F(s).G(s) then L^{-1} {F(s).G(s)} = f(t)* g(t)	Understand	CO 2	CLO 10	AHSB11.10
	MODULE-III					
1	Define the term curve fitting.	It is the process of finding the best fit curve for the set of given data values	Remember	CO 3	CLO 13	AHSB11.13
2	State through how many paired data points does fitting of the best straight line must pass through?	Through the three paired data points the fitting of the best straight line is obtained.	Understand	CO 3	CLO 13	AHSB11.13
3	Mention the principle involved in determining the best fit curve for the set of given data values.	The principle involved in determining the best fit curve for the set of given data values is the Method of least squares	Remember	CO 3	CLO 13	AHSB11.13
4	Describe the term principle of least squares in obtaining the best fit of the curve.	The principle of least squares is described as “Sum of the squares of the errors or residuals is minimum”	Remember	CO 3	CLO 13	AHSB11.13
5	State through how many paired data points does fitting of the best straight line must pass through?	Through the two paired data points the fitting of the best straight line is obtained.	Understand	CO 3	CLO 13	AHSB11.13
6	State the Normal equations of the straight line y = a + bx	The normal equations of the straight line y = a + bx are $\sum y = na + b\sum x$ $\sum xy = a\sum x + b\sum x^2$	Remember	CO 3	CLO 13	AHSB11.13
7	State the Normal equations of the second degree parabola y = a + bx +cx^2	The normal equations of the second degree parabola y = a + bx +cx^2 are $\varepsilon y = na + b\varepsilon x + c\varepsilon x^2$ $\varepsilon xy = a\varepsilon x + b\varepsilon x^2 + c\varepsilon x^3$ $\varepsilon x^2 y = a\varepsilon x^2 + b\varepsilon x^3 + c\varepsilon x^4$	Remember	CO 3	CLO 13	AHSB11.13
8	Define Fourier integral transforms	Fourier integral is a pair of integrals--a "lower Fourier integral" and an "upper Fourier integral"--which allow certain complex-valued functions f to be decomposed as the sum of integral-defined functions, each of which resembles the usual Fourier integral associated to f.	Remember	CO 3	CLO 14	AHSB11.14

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
9	State Fourier integral theorem.	If f(x) is a given function defined in (-*l*,*l*) and satisfies the Dirichlet conditions then $f(x)=\frac{1}{\pi}\int_{0}^{\infty}\int_{-\infty}^{\infty} f(t)\cos\lambda(t-x)dtd\lambda$	Understand	CO 3	CLO 14	AHSB11.14
10	State Fourier Sine integral formulae.	$f(x)=\frac{2}{\pi}\int_{0}^{\infty}\sin\lambda x\int_{0}^{\infty} f(t)\sin\lambda t dtd\lambda$	Remember	CO 3	CLO 14	AHSB11.14
11	State Fourier Cosine integral formulae.	$f(x)=\frac{2}{\pi}\int_{0}^{\infty}\cos\lambda x\int_{0}^{\infty} f(t)\cos\lambda t dtd\lambda$	Remember	CO 3	CLO 14	AHSB11.14
12	Define the term Integral transform	The integral transform of a function f(x) is given by I[f(x)] or F(s) $=\int_{a}^{b} f(x)k(s,x)dx$ Where k(s, x) is a known function called kernel of the transform, s is called the parameter of the transform, f(x) is called the inverse transform of F(s)	Remember	CO 3	CLO 15	AHSB11.15
13	Define Fourier transforms	The Fourier transform (FT) decomposes a function of time (a signal) into the frequencies that make it up, in a way similar to how a musical chord can be expressed as the frequencies (or pitches) of its constituent notes.	Remember	CO 3	CLO 15	AHSB11.15
14	Why to we need Fourier transforms	A complicated signal can be broken down into simple waves. This break down, and how much of each wave is needed, is the Fourier Transform. Fourier transforms (FT) take a signal and express it in terms of the frequencies of the waves that make up that signal.	Understand	CO 3	CLO 19	AHSB11.19
15	What is difference between Fourier series and Fourier transform?	The Fourier series is used to represent a periodic function by a discrete sum of complex exponentials, while the Fourier transform is then used to represent a general, non periodic function by a continuous superposition or integral of complex exponentials.	Understand	CO 3	CLO 19	AHSB11.19
16	How to represent Fourier transforms of function F(s)	Fourier transforms of function F(s) is defined by $F(s)\equiv\int_{-\infty}^{\infty} f(x)\,e^{-2\pi isx}\,dx$	Understand	CO 3	CLO 15	AHSB11.15
17	How to represent Inverse Fourier transforms of function f(x)	Inverse Fourier transforms of function f(x) is defined by $f(x)\equiv\int_{-\infty}^{\infty} F(s)\,e^{2\pi isx}\,ds$	Understand	CO 3	CLO 15	AHSB11.15
18	State linearity property of Fourier transforms	$F[af_1(x)+bf_2(x)]=aF_1(s)+bF_2(s)$	Understand	CO 3	CLO 15	AHSB11.15

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
19	State change of scale property of Fourier transforms	$F[f(ax)] = \frac{1}{a} F(\frac{s}{a})(a > 0)$	Understand	CO 3	CLO 15	AHSB11.15
20	State Modulation property of Fourier transforms	$F[f(x)\cos ax] = \frac{1}{2}\left[F(s+a)+F(s-a)\right], F[s] = F[f(x)]$	Understand	CO 3	CLO 15	AHSB11.15
21	Define Fourier sine transforms	The Fourier sine transform is he imaginary part of the full complex Fourier transform	Remember	CO 3	CLO 16	AHSB11.16
22	Define Fourier cosine transforms	The Fourier cosine transform is the a real part of the full complex Fourier transform.	Remember	CO 3	CLO 16	AHSB11.16
23	Define inverse Fourier transforms	A mathematical operation that transforms a function for a discrete or continuous spectrum into a function for the amplitude with the given spectrum; an inverse transform of the Fourier transform	Remember	CO 3	CLO 17	AHSB11.17
	MODULE-IV					
1	What is single step method in determining the numerical solution to ordinary differential equation?	Taylor's series method is single step method in determining the numerical solution to ordinary differential equation	Remember	CO 4	CLO 20	AHSB11.20
2	What are multi step methods in determining the numerical solution to ordinary differential equation?	Euler's method, Modified Euler's method and Runge-Kutta method are multi step method in determining the numerical solution to ordinary differential equation	Remember	CO 4	CLO 20	AHSB11.20
3	Define Taylor's series formulae.	$y(x) = y(0) + x.y'(0) + \frac{x^2}{2!} y''(0) + ... + \frac{x^n}{n!} y^n(0) + ...$	Remember	CO 4	CLO 20	AHSB11.20
4	State the Euler formula to determine the numerical solution of ordinary differential equation.	$y_{n+1} = y_n + hf(x_n, y_n)$	Understand	CO 4	CLO 20	AHSB11.20
5	State the second order Runge- Kutta method to determine the numerical solution of ordinary differential equation.	Second order R-K Formula $y_{i+1} = y_i+1/2 (K_1+K_2)$, Where $K_1 = h (x_i, y_i)$ $K_2 = h (x_i+h, y_i+k_1)$ For i= 0,1,2-------	Understand	CO 4	CLO 21	AHSB11.21
6	State the third order Runge- Kutta method to determine the numerical solution of ordinary differential equation.	Third order R-K Formula $y_{i+1} = y_i+1/6 (K_1+4K_2+ K_3)$, Where $K_1 = h (x_i, y_i)$ $K_2 = h (x_i+h/2, y_0+k_1/2)$ $K_3 = h (x_i+h, y_i+2k_2-k_1)$ For i= 0,1,2-------	Understand	CO 4	CLO 21	AHSB11.21
7	State the fourth order Runge- Kutta method to determine the numerical solution of ordinary differential equation	Fourth order R-K Formula $y_{i+1} = y_i+1/6 (K_1+2K_2+ 2K_3+K_4)$, Where $K_1 = h (x_i, y_i)$ $K_2 = h (x_i+h/2, y_i+k_1/2)$ $K_3 = h (x_i+h/2, y_i+k_2/2)$ $K_4 = h (x_i+h, y_i+k_3)$ For i= 0,1,2-------	Understand	CO 4	CLO 21	AHSB11.21
8	State the modified Euler formula to	${y^{(i)}}_{k+1} = y_k + h/2 f\left[(x_k, y_k) + f(x_{k+1}, 1)_{k+1}^{(i-1)}\right], i$	Understand	CO 4	CLO 20	AHSB11.20

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
	determine the numerical solution of ordinary differential equation.	For i=0,1,2,3				
9	List numerical method of single-step	Taylor's method is a single-step method	Remember	CO 4	CLO 20	AHSB11.20
10	List numerical method of step by step	Euler and Runge-Kutta methods are step by step methods	Remember	CO 4	CLO 21	AHSB11.21
11	Define boundary-value problem	If the conditions on y are prescribed at n distinct points, then the problems are called boundary-value problems	Remember	CO 4	CLO 20	AHSB11.20
12	Drawback of Taylor method	To evaluate higher order derivatives is difficult	Remember	CO 4	CLO 20	AHSB11.20
13	Which method is unsuitable if f(x,y) is given in tabular form	Taylor's form is unsuitable for tabular form of datas	Remember	CO 4	CLO 20	AHSB11.20
14	Which numerical method is powerful	Runge-Kutta method is very powerful	Understand	CO 4	CLO 21	AHSB11.21
15	Define initial value problems	The values of y are specified at the same value of x is called initial value problem.	Understand	CO 4	CLO 20	AHSB11.20
	MODULE-V					
1	Define the term partial differential equation	An equation involving partial derivatives of one dependent variable with respective more than one independent variables.	Remember	CO 5	CLO 22	AHSB11.22
2	Describe the formation of partial differential equation	A partial differential equation of given curve can be formed in two ways 1. By eliminating arbitrary constants 2. By eliminating arbitrary functions	Understand	CO 5	CLO 23	AHSB11.23
3	Write Lagrange's linear equation of a non linear partial differential equation	An equation of the form Pp + Qq = R is called Lagrange's linear equation.	Remember	CO 5	CLO 24	AHSB11.24
4	Write auxillary equation of Lagrange's linear partial differential equation	Lagrange's linear equation consider auxiliary equation is given by $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$	Remember	CO 5	CLO 24	AHSB11.24
5	Define first order equation	A differential equation involving partial derivatives p and q only and no higher order derivatives is called a first order equation.	Understand	CO 5	CLO 23	AHSB11.23
6	Write one example of linear p.d.e	The example of linear p.d.e is $px+qy^2=z$	Understand	CO 5	CLO 23	AHSB11.23
7	Write general solution of $P_p+Q_q=R$	$\phi(u,v)=0$	Understand	CO 5	CLO 24	AHSB11.24
8	Define order of p.d.e	Highest partial derivative appearing in the equation	Understand	CO 5	CLO 23	AHSB11.23
9	Describe one dimensional wave equation of partial differential equation	The equation which governs the motion of the vibrating string over time , is called the one-dimensional wave equation. It is a second order PDE, and it's linear and homogeneous.	Understand	CO 5	CLO 26	AHSB11.26

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
10	Describe one dimensional heat equation of partial differential equation	The equation which governs the mathematical model of how heat spreads or diffuses through an object such as a metal rod or a body of water.	Understand	CO 5	CLO 27	AHSB11.27
11	Express one dimensional wave equation of partial differential equation	$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$	Understand	CO 5	CLO 26	AHSB11.26
12	Express one dimensional heat equation of partial differential equation	$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$	Understand	CO 5	CLO 26	AHSB11.26
13	Express two dimensional laplace equation of partial differential equation	$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$	Understand	CO 5	CLO 26	AHSB11.26
14	Define the boundary conditions of one dimensional wave equation	y(0,t) = 0 for all t and y(l,t) = 0 for all t	Remember	CO 5	CLO 26	AHSB11.26
15	Define the boundary conditions of one dimensional heat equation	$u(0,t) = 0$ for all values of t and $u(l,t) = f(x)$ for $0 \le x \le l$	Remember	CO 5	CLO 26	AHSB11.26

Signature of the faculty **HOD, ME**