INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANIAL ENGINEERING

DEFINITIONS AND TERMINOLOGY

Course Name	:	**Mathematical Transform Techniques**
Course Code	:	**AHS011**
Program	:	**B.Tech**
Semester	:	**IV**
Branch	:	**Mechanical Engineering**
Section	:	**A,B**
Academic Year	:	**2018– 2019**
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OBJECTIVES

I	To help students to consider in depth the terminology and nomenclature used in the syllabus.
II	To focus on the meaning of new words / terminology/nomenclature

DEFINITIONS AND TERMINOLOGYQUESTION BANK

S No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
UNIT - I					
1	Define Fourier Series	Fourier Series is an expansion of a periodic function in terms an infinite series of trigonometric functions which represents an expansion or approximation of a periodic function, used in Fourier analysis.	Remember	CLO 01	CAHS011.01
2	Define Fourier Sine series	If f(x) is an odd function, then the Fourier Half Range sine series of f is defined to be $f(x)=\sum_{n=1}^{\infty} b_n \sin\frac{n\pi x}{L}$ $b_n=\frac{2}{L}\int_0^L f(x)\sin\frac{n\pi x}{L}\,dx, n\in\mathbb{N}.$	Remember	CLO 01	CAHS011.01
3	Define Fourier Cosine series	$f(x)=\frac{1}{2}a_0+\sum_{n=1}^{\infty} a_n\cos(nx),$	Remember	CLO 01	CAHS011.01
4	Define periodic signal	A signal is a periodic signal if it completes a pattern within a measurable time frame, called a period and repeats that pattern over identical subsequeperiods	Remember	CLO 01	CAHS011.01
4	Define Dirichlet conditions	The Dirichlet conditions are sufficient conditions for a real-valued, periodic function f to be equal to the sum of its Fourier series at each point where f is continuous. Moreover, the behavior of the Fourier series at points of discontinuity is determined as well (it is the midpoint of the values of the discontinuity).	Understand	CLO 01	CAHS011.01
5	When a function is said to absolutely Integrable?	An absolutely integrable function is a function whose absolute value is integrable, meaning that the integral of the absolute value over the whole domain is finite.	Understand	CLO 01	CAHS011.01
6	Define continuous functions	In mathematics, a continuous function is a function for which sufficiently small changes in the input result in arbitrarily small changes in the output. Otherwise, a function is said to be a discontinuous function	Remember	CLO 01	CAHS011.01

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7	Define discontinuous functions	If a function is not continuous at a point in its domain	Remember	CLO 01	CAHS011.01
8	Write the definition of even function?	A function f(x) is said to be even f(-x)=f(x)	Understand	CLO 01	CAHS011.01
9	Write the definition of odd function?	A function f(x) is said to be even f(-x)=f(x)	Understand	CLO 02	CAHS011.02
10	Define half range Fourier series.	It is required to obtain furrier series of a function f(x) in the interval (0,l)	Remember	CLO 02	CAHS011.02
12	What are fourier coefficients?	a_0, a_n and b_n	Understand	CLO 03	CAHS011.03
13	What are the conditions for expansion of a function in Fourier series?	1.f(x) is well defined ,single valued functions 2.f(x) has a finite number of discontinuities.	Remember	CLO 01	CAHS011.01
14	What is the value of sinx?	Sinx= sin(x+2π)= sinx	Understand	CLO 01	CAHS011.01
15	What is Fourier Series in Mathematics?	Fourier series is an infinite series representation of a periodic function in terms sines and cosines.	Remember	CLO 1	CAHS011.01
16	Define Fourier series in the interval c≤x≤c+2π	The Fourier series for the function f(x) in the interval c≤x≤c+2π is given by $f(x)=\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n \cos nx+b_n \sin nx)$ Where $a_0=\frac{1}{\pi}\int_c^{c+2\pi} f(x)dx$ $a_n=\frac{1}{\pi}\int_c^{c+2\pi} f(x)\cos nx\, dx$ $b_n=\frac{1}{\pi}\int_c^{c+2\pi} f(x)\sin nx\, dx$	Remember	CLO 1	CAHS011.01
17	What is the use of Fourier series?	Fourier series is used to solve ordinary and partial differential equations particularly with periodic functions appearing as non-homogeneous terms.	Remember	CLO 1	CAHS011.01
18	Define periodic function.	In mathematics, a periodic function is a function that repeats its values in regular intervals or periods. The most important examples are the trigonometric functions, which repeat over intervals of 2π radians	Remember	CLO 1	CAHS011.01

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19	What is the difference between Taylor's series and Fourier series?	Taylor's series expansion is valid only for functions which are continuous and differentiable. Fourier series is possible not only for continuous functions but also for periodic functions, functions which are discontinuous in their values and derivatives because of the periodic nature Fourier series constructed for one period is valid for all.	Remember	CLO 1	CAHS011.01
20	State Dirichlet conditions	A function f(x) has a valid Fourier series expansion if f(x) is well defined,periodic, single-valued and finite. f(x) has finite number of finite discontinuities in any one period . f(x) has finite number of finite maxima and minima in the interval of definition.	Understand	CLO 1	CAHS011.01
21	Where is Fourier Analysis used.	Fourier analysis is used in electronics, acoustics, and communications. Many waveforms consist of energy at a fundamental frequency and also at harmonic frequencies (multiples of the fundamental).	Understand	CLO 1	CAHS011.01
22	Discuss about the convergence of Fourier series.	Fourier series converges to f(x) at all points where f(x) is continuous. Also the series converges to the average of the left limit and right limit of f(x) at each point of discontinuity of f(x).	Understand	CLO 1	CAHS011.01
23	Define Fourier series in in [-l,l].	Let f(x) be a function defined in [-l,l] then the Fourier Series is given by $f(x)=\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos\frac{n\pi x}{l}+b_n\sin\frac{n\pi x}{l})$ Where $a_0=\frac{1}{l}\int_{-l}^{l}f(x)dx$ $a_n=\frac{1}{l}\int_{-l}^{l}f(x)\cos\frac{n\pi x}{l}\,dx$ $b_n=\frac{1}{l}\int_{-l}^{l}f(x)\sin\frac{n\pi x}{l}\,dx$	Remember	CLO 1	CAHS011.01
24	Define odd function .	A function f(x) is said to be even f(-x)= - f(x)	Remember	CLO 2	CAHS011.02
25	Define half range sine series in [0,l].	$f(x)=\sum_{n=1}^{\infty}(b_n\sin\frac{n\pi x}{l})$ Where $b_n=\frac{2}{l}\int_{0}^{l}f(x)\sin\frac{n\pi x}{l}\,dx$	Remember	CLO 3	CAHS011.03
26	State Fourier series for even function in [-π,π].	When f(x) is an even function $f(x)=\frac{a_0}{2}+\sum_{n=1}^{\infty}a_n\cos nx$ Where $a_0=\frac{2}{\pi}\int_{0}^{\pi}f(x)dx$	Understand	CLO 3	CAHS011.03

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		$a_n = \frac{2}{\pi}\int_0^{\pi} f(x)\cos nx\, dx$			
27	State Fourier series for odd function in [-π,π].	When f(x) is an Odd Function $f(x)= \sum_{n=1}^{\infty} b_n \sin nx$ Where $b_n = \frac{2}{\pi}\int_0^{\pi} f(x)\sin nx dx$	Remember	CLO 3	CAHS011.03
28	What is the period of sin3x?	The period of sin3x is $\frac{2\pi}{3}$	Understand	CLO 1	CAHS011.01
UNIT – II					
1	Define Fourier integral transform.	Fourier Integral transforms are mathematical devices form which we obtain the solutions of boundary value problems related to Engineering.Example conduction of heat ,free and forced vibrations of a membrane ,tranverse vibrations of a string,tranverse oscillations of an elastic beam.	Remember	CLO 3	CAHS011.03
2	Define Fourier integral transform theorem.	If f(x) is a given function defined in (-l,l) and satisfies the Dirichlet conditions then $f(x) = \frac{1}{\pi}\int_0^{\infty}\int_{-\infty}^{\infty} f(t)\cos\lambda(t-x)dtd\lambda$	Remember	CL0 5	CAHS011.05
3	State shifting property of Fourier transform.	If F(p) is Fourier transform of f(x) then the Fourier transform of f(x-a) is $e^{ipa}f(p)$	Understand	CLO 6	CAHS011.06
4	State change of scale property.	If F(p) is Fourier transform of f(x) then the Fourier transform of f(ax) is $\frac{1}{a} f\left(\frac{p}{a}\right)$	Understand	CLO 6	CAHS011.06
5	State Modulation theorem.	If F(p) is Fourier transform of f(x) then the Fourier transform of f(x)cosax is $\frac{1}{2}[F(p+a)+F(p+a)]$	Understand	CLO 4	CAHS011.04
6	State Linearity property of Fourier transform.	If F(p) and G(p) are Fourier transform of f(x) and g(x) respectively then F[af(x)+bg(x)]= aF(p)+bG(P)	Understand	CLO 6	CAHS011.06

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7	Define Fourier transform and inverse Fourier transform.	The Fourier transform and inverse transform are $$F(s)=\int_{-\infty}^{\infty} f(t)e^{ist}dt$$ $$f(x)=\frac{1}{2\pi}\int_{-\infty}^{\infty} F(s)e^{-isx}ds$$	Remember	CLO 7	CAHS011.07
8	Define Fourier cosine integral.	If f (t) is an even function $$f(x)=\frac{2}{\pi}\int_{0}^{\infty}\cos\lambda x\int_{0}^{\infty} f(t)\cos\lambda t dt d\lambda$$ Fourier cosine integral.	Remember	CLO 5	CAHS011.05
9	State Dirichlet's conditions.	A function f(x) is said to satisfy Dirichlet's conditions in the interval (a,b) if f(x) defined and is single valued function except possibly at a finite number of points in the interval (a,b) f(x) and $f^1(x)$ are piecewise continuous in (a,b)	Understand	CLO 6	CAHS011.06
10	Define Fourier Sine Integral	If f (t) is an odd function $$f(x)=\frac{2}{\pi}\int_{0}^{\infty}\sin\lambda x\int_{0}^{\infty} f(t)\sin\lambda t dt d\lambda$$ is known Fourier Sine Integral	Remember	CLO 5	CAHS011.05
11	Define Fourier cosine integral.	If f (t) is an even function $$f(x)=\frac{2}{\pi}\int_{0}^{\infty}\cos\lambda x\int_{0}^{\infty} f(t)\cos\lambda t dt d\lambda$$ Fourier cosine integral.	Remember	CLO 6	CAHS011.06
12	Define Fourier transforms	The Fourier transforms (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	CLO 03	CAHS011.03
13	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	Remember	CLO 03	CAHS011.03

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		be decomposed as the sum of integral-defined functions, each of which resembles the usual fourier integral associated to f.			
14	Define fourier sine transforms.	the fourier sine transform is the imaginary part of the full complex fourier transform.	Remember	CLO 03	CAHS011.03
15	Define Fourier cosine transforms.	The Fourier cosine transform is the areal part of the full complex Fourier transform.	Remember	CLO 03	CAHS011.03
16	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	CLO 03	CAHS011.03
17	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	CLO 03	CAHS011.03
18	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	CLO 03	CAHS011.03
19	Define piece wise continuous functions	In mathematics, a piecewise-defined function (also called a piecewise function or a hybrid function) is a function defined by multiple sub-functions, each sub-function applying to a certain interval of the main function's domain, a sub-domain	Remember	CLO 03	CAHS011.03
20	How to represent Fourier transforms of function F(s).	Fourier transforms of function F(s) is defined by Fourier transforms of function F(s) $$F(s) \equiv \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i s x}\, dx$$	Understand	CLO 03	CAHS011.03
21	How to represent Fourier transforms of function f(x)	$$f(x) \equiv \int_{-\infty}^{\infty} F(s)\, e^{2\pi i s x}\, ds$$	Understand	CLO 03	CAHS011.03
UNIT – III					
1	What is Laplace transform?	Laplace transform is a tool for engineers and scientist because these transforms provide easy and powerful means of solving differential equations.	Remember	CLO 9	CAHS011.09

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2	What is the importance of Laplace transform?	Laplace transform directly provide the solution of initial value problems or boundary value problems without finding the general solution differential equations.	Understand	CLO 9	CAHS011.09
3	State the conditions for existence of Laplace Transform.	The Laplace Transform of f(t) is said to exist if the integral $\int_0^\infty e^{-st} f(t)dt$ converges for some value of s,otherwise it does not exist.	Remember	CLO 9	CAHS011.09
4	What is inverse Laplace transform.	If $\overline{f}(s)$ is the Laplace Transform of a function f(t) then f(t) is called inverse Laplace transform of $\overline{f}(s)$	Understand	CLO 9	CAHS011.09
5	State first translation theorem	Laplace transform of a function f(t) is multiplied by e^{at} then changes to be made from s to s-a in resulting L[f(t)]	Understand	CLO 9	CAHS011.09
6	Define HeavisideUnit step function	The unit step function is defined as u(t-a) if t<a the value is 0 and t>a the value is 1	Remember	CLO 9	CAHS011.09
7	What is the Laplace transform of 1	The laplace transform of 1 is $\frac{1}{s}$	Understand	CLO 9	CAHS011.09
8	What is the Laplace transform of f'(t)	L[f'(t)] = sL[f(t)]-f(0)	Remember	CLO 9	CAHS011.09
9	What is Laplace transform of e^{at}	Laplace transform of e^{at} is $\frac{1}{s-a}$	Remember	CLO 9	CAHS011.09
10	Describe Laplace transform of integrals	The whole L[f(t)] is divided by s	Remember	CLO 9	CAHS011.09
12	What is Laplace transform of {tsinat}	Laplace transform of 2as	Understand	CLO 9	CAHS011.09
13	Define periodic function	A function f(t) is said to be periodic iff f(t+T) = f(t)	Remember	CLO 9	CAHS011.09
14	Define inverse Laplace transform	If f(s) is the Laplace transform of a function f(t) then f(t) is called the inverse Laplace transform of f(s)	Remember	CLO 9	CAHS011.09
15	State use of partial fractions in finding inverse Laplace transform	If f(s) is g(s)/h(s) where g and h are polynomials in s then f(t) is obtained by resolving f(s) into partial fractions and manipulating term by term.	Understand	CLO 9	CAHS011.09
16	Define convolution theorem	f(t)*g(t) is equal to integrating with respect to u from 0 to t of f(u)g(t-u)	Remember	CLO 9	CAHS011.09

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17	Define Laplace transform	Laplace transform of a function f(t) is f(t) is multiplied by e^{-st} and integrating from 0 to ∞	Remember	CLO 09	CAHS011.09
18	State sufficient conditions for the existence of Laplace transform of a function	The function f(t) must be piece-wise continuous in any limited interval and the function is of exponential order	Understand	CLO 09	CAHS011.09
19	State piece-wise continuous function	A function f(t) is said to be piece-wise continuous over the closed interval [a,b] if it is divided into a finite number of subintervals where f(t) is continuous and has right and left hand limits at every end point of the subinterval	Understand	CLO 09	CAHS011.09
20	State Linearity property	Laplace transform of the sum of two or more functions of t is the sum of the Laplace transforms of the separate functions	Understand	CLO 09	CAHS011.09
21	State first shifting theorem	Laplace transform of a function f(t) is multiplied by e^{at} then changes to be made from s to s-a in resulting L[f(t)]	Understand	CLO 09	CAHS011.09
22	Define Unit step function	The unit step function is defined as u(t-a) if t<a the value is 0 and t>a the value is 1	Remember	CLO 09	CAHS011.09
23	State change of scale property	L[f(at)] is finding Laplace transform of function f(t) where changes to be made s to s/a , the whole is multiplied by 1/a	Understand	CLO 09	CAHS011.09
24	Define Laplace transform of derivatives	If f(t) is continuous and of exponential order, and f'(t) is sectionally continuous then the L[f(t)] = L[f(t)]-f(0)	Remember	CLO 09	CAHS011.09
25	Define Laplace transform of t^n f(t)	Laplace transform of t^n f(t) is $(-1)^n$ is multiplied by n^{th} derivative of L[f(t)]	Remember	CLO 09	CAHS011.09
26	Define Laplace transform of integrals	The whole L[f(t)] is devided by s	Remember	CLO 09	CAHS011.09
27	State Laplace transform of Dirac delta function	Laplace transform of Dirac delta function is e^{-as}	Understand	CLO 09	CAHS011.09
28	Define periodic function	A function f(t) is said to be periodic iff f(t+T) = f(t)	Remember	CLO 09	CAHS011.09
29	Define inverse Laplace transform	If f(s) is the Laplace transform of a function f(t) then f(t) is called the inverse Laplace transform of f(s)	Remember	CLO 09	CAHS011.09
30	State use of partial fractions in finding inverse Laplace transform	If f(s) is g(s)/h(s) where g and h are polynomials in s then f(t) is obtained by resolving f(s) into partial fractions and manipulating term by term	Understand	CLO 09	CAHS011.09
31	Define convolution theorem	f(t)*g(t) is equal to integrating with respect to u from 0 to t of f(u)g(t-u)	Remember	CLO 09	CAHS011.09

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UNIT - IV					
1	Define z-transform.	Consider a function f(n) defined for n=1,2,3… then the z- transform of f(n) is defined as Z[f(n)] = $\sum_{n=0}^{\infty} f(n)\, z^{-n}$	Remember	CLO 13	CAHS011.13
2	Describe inverse z-transform.	The inverse z-transform of F(z) is defined as $Z^{-1}[F(z)] = f(n)$	Remember	CLO 13	CAHS011.13
3	Explain about the importance of z-transform.	The z-transform is useful in solving difference equations. It is used extensively today in the areas of applied mathematics, digital signal processing, control theory, population science, economics.	Understand	CLO 13	CAHS011.13
4	State linearity property of z-transform	a,b are any constants and f(n) and g(n) be any discrete functions then Z[af(n)+bg(n)] = aZ[f(n)] + bZ[g(n)].	Understand	CLO 13	CAHS011.13
5	E xplain change of scale property of z-transform.	If Z[f(n)] = F(z) then Z[$a^{-n} f(n)] = F(az)$	Understand	CLO 13	CAHS011.13
6	State Initial value theorem of z-transform	If Z[f(n)] = F(z) then $\underset{z\to\infty}{\text{Lt}}\ F(z) = f(0)$	Understand	CLO 13	CAHS011.13
7	State Final value theorem of z-transform.	If Z[f(n)] = F(z) then $\underset{n\to\infty}{\text{Lt}}\ F(n) = \underset{z\to 1}{\text{Lt}}\ (z-1)F(z)$	Understand	CLO 13	CAHS011.13
8	State multiplication by n of Z- transform.	If Z[f(n)] = F(z) then $Z[nf(n)] = -z\dfrac{d}{dz}F(z)$	Understand	CLO 13	CAHS011.13
9	State division by n of Z-transform	If Z[f(n)] = F(z) then $Z\left[\dfrac{f(n)}{n}\right] = -\int\left[\dfrac{F(z)}{z}\right]dz$	Understand	CLO 13	CAHS011.13
10	State convolution theorem of Z- transform.	$Z^{-1}[F(z)] = f(n)$ and $Z^{-1}[G(z)] = g(n)$ $Z^{-1}[F(z).G(z)] = f(n) * g(n) =$ $\sum_{m=0}^{n} f(m)g(n-m)$	Understand	CLO 13	CAHS011.13
11	What is the Z-transform of unit impulse function?	The Z-transform of unit impulse function is $\frac{z}{z-1}$	Understand	CLO 13	CAHS011.13

S No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
12	State shifting property to the right.	If Z[f(n)] = F(z) then Z[f(n-k)]= $z^{-k}F(z)$.	Understand	CLO 13	CAHS011.13
13	What is the Z-transform of a^n	The Z-transform of a^n is $\frac{z}{z-a}$	Understand	CLO 13	CAHS011.13
14	What is the inverse Z-transform of $\frac{4a}{z-a}$	The inverse Z-transform of $\frac{4a}{z-a}$ is $4a^n$	Understand	CLO 13	CAHS011.13
15	What is the Z-transform of unit impulse function?	The Z-transform of unit impulse function is $\frac{z}{z-1}$	Understand	CLO 13	CAHS011.13
UNIT - V					
1	Describe partial differential equation	A differential equation which involves partial derivatives is called a partial differential equation.	Remember	CLO 17	CAHS011.17
2	What is the order of partial differential equation	The order of partial differential equation is the highest partial derivative appearing in the equation .	Remember	CLO 17	CAHS011.17
3	What is the degree of partial differential equation	Degree of partial differential equation is the highest order derivative.	Remember	CLO 17	CAHS011.17
4	Explain the formation of partial differential equation	partial differential equation is formed either by the elimination of arbitrary constants or by the elimination of arbitrary functions from a relation involving three or more variables.	Understand	CLO 17	CAHS011.17
5	Explain the rule of PDE to be of first order	If the number of constants to be eliminated is equal to the number of independent variables the derived PDE is of first order.	Understand	CLO 17	CAHS011.17
6	Describe rule of PDE to be of second or higher order	If the number of constants to be eliminated is greater than the number of independent variables then the elimination of the constants will give rise to a PDE is of second or higher order.	Understand	CLO 17	CAHS011.17
7	State Lagrange's linear equation.	A linear PDE of order one, involving a dependent variable z and two independent variables x and y of the form Pp+Qq =R where P,Q,R are functions of x,y,z is called Lagrange's linear equation.	Remember	CLO 17	CAHS011.17
8	Describe non-linear partial differential equation.	A PDE which involves first order partial derivatives p and q with degree higher than one and the products of p and q is called a non-linear partial differential equation.	Remember	CLO 17	CAHS011.17
9	Describe complete integral.	A solution in which the number of arbitrary constants is equal to the number of independent variables is called complete integral.	Remember	CLO 17	CAHS011.17

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10	Explain e particular integral	A solution obtained by giving particular values to the arbitrary constants in the complete integral is called a particular integral	Remember	CLO 17	CAHS011.17
11	Describe singular integral	The method of solving a non –linear PDE f(x,y,z,p,q)=0 is called	Remember	CLO 17	CAHS011.17
12	Define Charpit's Method.	The method of solving a non –linear PDE f(x,y,z,p,q)=0 is called Charpit's Method.	Remember	CLO 17	CAHS011.17
13	State standard form I.	Equations of the form f(p,q)=0 that is equations containing p and q only.	Remember	CLO 17	CAHS011.18
14	State standard form II.	Equations of the form f(z,p,q) = 0 that is equations not containing x and y only.	Remember	CLO 17	CAHS011.18
15	State standard form III.	Equations of the form f1(x,p) = f2(y,q) that is equations not involving z and the terms containing x and p can be separated from those containing and y and y.	Remember	CLO 17	CAHS011.18

Signature of the Faculty **Signature of the HOD**