DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 1 –ROOTS OF EQUATION & ERROR APPROXIMATIONS

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

	Errors		
Q.1	Explain: i) Round off error ii) Truncation error	4
Q.2	Explain: i) Round off error ii) Error Propagation	6
Q.3	What is Error Propagation? Explain Error Propagation with respect to- 1. Addition 2. Subtraction 3.Multiplication 4.Division	6
Q.4	Explain: 1.Error Propagation 2.Round off error 3.Truncation error 4. Absolute error with example.	8
Q.5	Explain: 1.Rounding error 2.Truncation error 3. Absolute error 4. Relative error with example.	8
	Roots of Equation	
Q.6	Find the root of the equation 3x + sinx– e^x=0 by the successive approximation Method correct to 2 decimal places.	6
Q.7	Volume of cylinder is calculated after measuring its diameter as (2.5 ± 0.02) m and its height as (4.8 ± 0.05) m respectively. Estimate the absolute error in calculation of volume.	6
Q.8	Determine the real root of the equation ex = 5x using method of successive approximation. Assume initial guess x = 0.15 and solve upto 5 iterations	6
Q.9	Explain the concept of convergence in Newton Raphson method	6
Q.10	Draw the flow chart for Bisection method.	6
Q.11	Solve the equation e^x.cos x – 1.2 sin x – 0.5 = 0 by successive approximation method. Do 3 iterations.	8
Q.12	Using Newton's iterative method, find the real root of $x \log_{10} x = 1.2$ correct to five decimal places.	8
Q.13	Find by Newton's method, the real root of the equation 3x = cos x + 1, correct to four decimal places.	8
Q.14	Using three iterations of bisection method, determine root of the equation. Initial guesses are $x_1 = 2.8$ and $x_2 = 3$,$f(x) = - 0.9 x^2 + 1.7x + 2.5$	8
Q.15	Use Bisection method to obtain the root of x*ex -5 cos x=0 Start with initial guess -1.5 and 2.0. Desired accuracy is ± 0.01	9
Q.16	Draw the flow chart for Newton Raphson method	6
Q.17	Draw the flow chart for of Successive approximation method.	6

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QUESTION BANK

UNIT NO. 2 -SIMULTANEOUS EQUATIONS

SUBJECT: 302047 Numerical Methods and Optimization
COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Q.1 Solve the following system of equation using Gauss elimination method. 8

3x + 2y + 3z = 18;
2x + y + z = 10;
x + 4y + 9z = 16

Q.2 When does the Gauss elimination method fail? Explain 2

Q.3 Solve following set of equations using Gauss Elimination Method. 8

3X + 6Y + Z = 16
2X + 4Y + 3Z = 13
X + 3Y + 2Z = 9

Q.4 Draw a flowchart for Gauss elimination method. 6

Q.5 Apply Gauss elimination method to solve the following equations: Each 8

i) x+4y-z=-5; x+y-6z=-12; 3x-y-z=4

ii) 10x-7y+3z+5u=6; -6x+8y-z-4u=5; 3x+y+4y+11u=2; 5x-9y-2z+4u=7

iii) x+y+z=9; 2x-3y+4z=13; 3x+4y+5z=40

iv) 2x+y+z=12; 3x+2y+3z=8; 5x+10y-8z=10

v) 2x+2y+z=12; 3x+2y+2z=8; 5x+10y-8z=10

vi) 2x1+4x2+x3=3; 3x1+2x2-2x3=-2; x1-x2+x3=6

vii) $5x_1+x_2+x_3+x_4=4$; $x_1+7x_2+x_3+x_4=12$; $x_1+x_2+6x_3+x_4=-5$; $x_1+x_2+x_3+4x_4=-6$

viii) 2x+y+z=10; 3x+2y+3z=18; x+4y+9z=16

ix) 2x-3y+z=-1; x+4y+5z=25; 3x-4y+z=2

x) x+3y+3z=16; x+4y+3z=18; x+3y+4z=19

xi) $2x_1+x_2+5x_3+x_4=5$; $x_1+x_2-3x_3+4x_4=-1$; $3x_1+6x_2-2x_3+x_4=8$; $2x_1+2x_2+2x_3-3x_4=2$

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 2 -SIMULTANEOUS EQUATIONS

SUBJECT: 302047 Numerical Methods and Optimization
COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Q.6	Using Gauss Seidal method, solve the following set of equations up to 3 decimal places. $3x + y - z = 0$, $x + 2y + z = 0$, $x - y + 4z = 3$	8
Q.7	Using Gauss Seidal iteration method, solve the following set of equations up to 5 iteration $4x + 2z = 4$, $5x + 2z = 3$, $5x - 4y + 10z = 2$	8
Q.8	Apply Gauss – Seidal iteration method to solve the following equations: i) $20x+y-2z=17$; $3x+20y-z=-18$; $2x-3y+20z=25$ ii) $10x_1-2x_2-x_3-x_4=3$; $-2x_1+10x_2-x_3-x_4=15$; $-x_1-x_2+10x_3-2x_4=27$; $-x_1-x_2-2x_3+10x_4=-9$ iii) $2x+y+6z=9$; $8x+3y+2z=13$; $x+5y+z=7$ iv) $10x+y+z=12$; $2x+10y+z=13$; $2x+2y+10z=14$ v) $54x+y+z=110$; $2x+15y+6z=72$; $-x+6y+27z=85$ vi) 10x1-2x2-x3-x4=3; -2x1+10x2-x3-x4=15; -x1-x2+10x3-2x4=27; -x1-x2-2x3+10x4=-9	Each 8
Q.9	Draw flow chart for Gauss – Seidal method	
Q.10	Using Thomas Algorithm Method, solve the following set of simultaneous equations $5a - b = 5.5$; $-a + 5b - c = 5$; $-b + 5c - d = 11.5$; $-c+5d=16.5$	8
Q.11	Solve the following tri-diagonal system with the Thomas algorithm:	

$$\begin{bmatrix} 2.04 & -1 & 0 & 0 \\ -1 & 2.04 & -1 & 0 \\ 0 & -1 & 2.04 & -1 \\ 0 & 0 & -1 & 2.04 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} = \begin{bmatrix} 40.8 \\ 0.8 \\ 0.8 \\ 200.8 \end{bmatrix}$$

Q.12	Solve the following tri-diagonal system with the Thomas algorithm: $10x_1+2x_2=12$ $2x_1+9x_2+3x_3=14$ $x_2 + 10x_3 + 4x_4 = 15$ $3x_3 + 11x_4 = 14$	8
Q.13	Draw flow chart for Thomas algorithm method	5

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QUESTION BANK

UNIT NO. 3 - OPTIMIZATION

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Q.1	Maximize Z = 6x1 + 4x2 subject to condition, 2x1 + 3x2 ≤ 100 4x1 + 2x2 ≤ 120 x1, x2 ≥ 0 Use Simplex Method to calculate x1, x2 and maximize profit Z.	10
Q.2	Minimize Z = 2x + 3y subject to condition 2x + 4y ≥ 80 4x + 2y ≥ 100 x ≥ 0, y ≥ 0	8
Q.3	Define optimization. Write its engineering applications.	2
Q.4	A company is manufacturing two different types of products A and B. Each product has to be processed on two machines M1 and M1. Product A requires 2 hours on machine M1 and 1 hour on machine M2. Product B requires 1 hour on machine M1 and 2 hours on machine M2. The available capacity of machine M1 is 104 hours and that of machine M2 is 76 hours Profit per unit for product A is Rs.6 and that for product B is Rs. 11. i)Formulate the problem. ii) Find the optimal solution by simplex method.	6
Q.5	Determine the maximum value of root of equation. 0.51 (x) - sin (x) by Newton's method. Take initial guess as 2 and do 4 iterations.	5
Q.6	Write a short note on Genetic Algorithm.	3
Q.7	Maximize Z=6x+4y. Subjected to condition , 2x+3y ≤ 100, 4x + 2 y ≤ 120 , x ≥ 0, y ≥ 0	10
Q.8	Write the short note on optimization techniques Simulated annealing	4
Q.9	Minimize, Z=2x+3y. Constraints are, 2x+4y ≤ 80 4x + 2y ≤ 100 & x ,y ≥ 0.	6

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QUESTION BANK

UNIT NO. 3 - OPTIMIZATION

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Q.10	Maximize, $Z=2x_1+5x_2$ Constraints are, $x_1+4x_2 \le 24$ $3x_1+x_2 \le 21$ $x_1+x_2 \le 9$, x_1, $x_2 \ge 0$.	10
Q.11	Maximize Z=1600x+1500y. Constraints are, $5x+4y \le 500$ $15x+16y \le 1800$ & $x \ge 0$, $y \ge 0$	10
Q.12	Write the short note on the optimization technique Genetic algorithm	4

DEPARTMENT OF MECHANICAL ENGINEERING
QUESTION BANK
UNIT NO. 4 - NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS
SUBJECT: 302047 Numerical Methods and Optimization
COURSE : TE (2015 Pattern)
THEORY QUESTIONS

Taylor's series method

Q.1 Solve $y` = x + y$, $y(0) = 1$ by Taylor's series method. Hence find the values of y at x = 0.1 and x = 0.2. 8

Q.2 Find by Taylor's series method, the values of y at x = 0.1 and x = 0.2 to five places of decimals from $\frac{dy}{dx} = x^2y - 1$, $y(0) = 1$. 8

Q.3 Using Taylor's series method, compute y (0.2) to three places of decimal from $\frac{dy}{dx} = 1 - 2xy$ given that $y(0) = 0$. 8

Q.4 Solve $y` = y2 + x$, $y(0) = 1$ using Taylor's series method and compute $y(0.1)$ and $y(0.2)$. 8

Euler's method

Q.5 Using Euler's method, find an approximate value of y corresponding to x = 1 given that $\frac{dy}{dx} = x + y$ and $y = 1$ when $x = 0$. 8

Q.6 Given $\frac{dy}{dx} = y - x/y + x$ with initial condition $y = 1$ at $x = 0$; find y for $x = 0.1$ by Euler's method. 8

Q.7 Using modified Euler's method, find an approximate value of y when $x = 0.3$ given that $\frac{dy}{dx} = x + y$ and $y = 1$ when $x = 0$. 8

Q.8 Solve the following by Euler's modified method: $\frac{dy}{dx} = \log(x + y)$, $y(0) = 2$ 8

Runge – Kutta 2nd order

Q.9 Solve the following differential equation to find value of 'y' at given value of 'x' by using Runge Kutta method of 2th order. Solve the equation 8

$$2\frac{d^2y}{dx^2} = 3x\frac{dy}{dx} - 9y + 9$$

Subject to the conditions y(0) = 1, y′(0) = −2 compute y for x = 0.1

Q.10 Solve the following differential equation to find value of 'y' at given value of 'x' by using Runge Kutta method of 2th order. 8

$\frac{dy}{dx} = x + y / z$ and $\frac{dz}{dx} = x*y + z$ with x0=0.5 and y0=1.5 , z0=1

compute y and z for x = 0.6

Runge – Kutta 4th order

Q.11 Apply Runge – Kutta fourth order method to find an approximate value of y when $x = 0.2$ given that $\frac{dy}{dx} = x + y$ and $y = 1$ when $x = 0$. 8

Q.12 Using Runge – Kutta method of fourth order, solve $\frac{dy}{dx} = y^2 - x^2 / y^2 + x^2$ 8

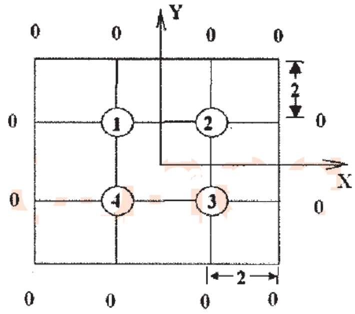
THEORY QUESTIONS

with $y(0) = 1$ at $x = 0.2, 0.4$.

Q.13 Use Runge – Kutta method to approximate y when $x = 1.1$, given that $y = 1.2$ when $x = 1$ and $\frac{dy}{dx} = 3x + y^2$. — 8

Q.14 Using fourth order Runge – Kutta method, find y at $x = 0.1$ given that $\frac{dy}{dx} = 3e^x + 2y$, $y(0) = 0$ and $h = 0.1$. — 8

Q.15 Solve the equation $\frac{d2y}{dx2} + 2\frac{d2u}{dy2} = \frac{1}{xy}$ corresponding to grid shown in the following fig. — 8



Q.16 Draw a flow chart for Poisson's equation — 8

Q.17 Draw a flow chart for Laplace eueation — 8

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QUESTION BANK

UNIT NO. 5 - CURVE FITTING & REGRESSION ANALYSIS

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Q.1 If P is the pull required to lift a load W by means of a pulley block, find a liner law of the form P = mW+c connecting P and W, using following data: 8

P =	12	15	21	25
W =	50	70	100	120

Where P and W are taken in kg-wt. Compute P when W = 150 kg.

Q.2 By the method of least squares, find the straight line that best fits the following data: 6

x	1	2	3	4	5
y	14	27	40	55	68

Q.3 Fit a curve $y = ax^b$ using following data 8

X	2000	3000	4000	5000	6000
Y	15	15.5	16	17	18

Q.4 In some determination of the value v of carbon dioxide dissolved in a given volume of water at different temperature Ə, the following pair of values were obtained. 8

Ə	0	5	10	15
v	1.80	1.45	1.18	1.00

Obtain by method of least square, a relation of the form v = a + b Ə which best fit to these observations.

Q.5 The pressure of the gas corresponding to various volume V is measured, given by the following data. Fit the data to the equation $\mathbf{PV^{\gamma}=c}$ 8

V(cm^3)	50	60	70	90	100
P(kg/cm^3)	64.7	51.3	40.5	25.9	78

Q.6 Using method of least squares, fit a relation of the form $y = ab^x$ to the following data: 8

x	2	3	4	5	6
y	144	172.8	207.4	248.8	298.5

Q.7 Fit a geometric curve for $y = ax^b$ for the following data: 8

x	5	15	20	25	30
y	0.5	1	1.5	2	2.5

Q.8 Using method of least squares, fit a relation of the form $y = A.e^{bx}$ to the following data: 8

x	1	2	3	4	5
y	4	6	8	9	12

Q.9 Use Lagrange's Interpolation formula to find the value of y when x= 10 If the following values of x & y are given 8

x	5	6	9	11
y	12	13	14	16

Q.10 Draw flow-chart for interpolation using Newton's Forward difference 6

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QUESTION BANK

UNIT NO. 5 - CURVE FITTING & REGRESSION ANALYSIS

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Interpolation.

Q.11 Find the polynomial passing through points (0,1) (1,1) (2,7) (3,25) (4,61)(5,12) using Newton's interpolation formula and hence find y and dy/dx at x=0.5 — 8

Q.12 Use the exponential model for $y = ae^{bx}$ to fit the data: — 8

x	**2**	**4**	**6**	**8**
y	**25**	**38**	**56**	**84**

Q.13 The pressure and volume of a gas are related by the equation pVγ = k, γ and k being constants. Fit this equations for the following set of observations: — 8

p (kg/cm2)	0.5	1.0	1.5	2.0	2.5	3.0
V (liters)	1.62	1.00	0.75	0.62	0.52	0.46

Q.14 Explain the term 'Interpolation', 'Extrapolation' and 'Inverse interpolation'. — 8

Q.15 3 A set of x and y are given below using Newton's forward interpolation formula find y(1.105). — 8

X	1.0	1.1	1.2	1.3	1.4	1.5	1.6
Y	0.0	0.331	0.728	1.207	1.744	2.375	3.096

Q.16 A set of values x and f(x) are given below. Using Lagrange's interpolation formula, find f(9) — 8

X	5	7	11	13	17
F(x)	150	392	1452	2366	5202

Q.12

Q.13 Find value of y for x=0.5 for the following table of x,y values using Newton's forward difference formula — 8

X	0	1	2	3	4
Y	1	5	25	100	250

Q.14 Apply the Hermite's formula to find a polynomial from the following data and then find y(0.5) — 10

X	Y	Y'
0	0	0
1	1	0
2	0	0

Q.15 Apply Hermite Interpolation to find the value of f(0.4) for the given table — 10

X	F(x)	F'(x)
0	0	0
1	1	2

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 6 – NUMERICAL INTEGRATION

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Trapezoidal Rule

Q.1 Use trapezoidal rule to evaluate $\int_0^1 x^3 \, dx$ considering five sub-intervals 6

Q.2 Evaluate $\int_0^1 \frac{dx}{1+x^2}$ using Trapezoidal rule. 8

Q.3 Given that: 8

x	4.0	4.2	4.4	4.6	4.8	5.0	5.2
log x	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

Evaluate $\int_4^{5.2} \log x \, dx$

Q.4 Evaluate following integrals by applying trapezoidal rule: 8

(i) $\int_0^2 (3x^2 + 2x - 5) \, dx$ for n = 5

(ii) $\int_0^2 (3x^3 + 2x^2 - 1) \, dx$ for n = 5

(iii) $\int_0^{\pi} (3\cos x + 5) \, dx$ for n = 8

Q.5 Estimate the following my trapezoidal method. 8

(i) $\int_1^3 \frac{dx}{x}$ n = 8

(ii) $\int_1^2 \frac{e^x dx}{x}$ n = 4

(iii) $\int_1^5 e^{-x^2} \, dx$ n = 8

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QUESTION BANK
UNIT NO. 6 – NUMERICAL INTEGRATION
SUBJECT: 302047 Numerical Methods and Optimization
COURSE : TE (2015 Pattern)
THEORY QUESTIONS

(iv) $\int_0^3 cos^2x\,dx$ n = 6

(v) $\int_0^{\pi} \sqrt{1+3cos^2x\,dx}$ n = 6

(vi) $\int_0^2 \left(e^{x^2}-1\right)$dx n = 8

Simpson's 1/3rd Rule

Q.6 Use Simpson's 1/3rd rule to find $\int_0^{0.6} e^{-x^2}\,dx$ by taking 7 ordinates. 8

Q.7 The velocity v (km/min) of a moped which starts from rest, is given at fixed intervals of time t (min) as follows: 8

t:	2	4	6	8	10	12	14	16	18	20
v:	10	18	25	29	32	20	11	5	2	0

Estimate approximately the distance covered in 20 minutes.

Q.8 A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the lines x=0 and x=1 and a curve through the points with the following co-ordinates : 8

x:	0.00	0.25	0.50	0.75	1.00
y:	1.0000	0.9896	0.9589	0.9089	0.8415

Estimate the volume of the solid formed using Simpson's 1/3rd rule.

Q.9 Calculate the value of $\int_0^{\pi} \sin x\ \ dx$ by Simpson's 1/3rd rule, using 11 ordinates. Verify your answer by direct integration. 8

Q.10 Evaluate $\int_4^{5.2} \log x\ \ dx$ by Simpson's 1/3rd rule, using given table : 8

x:	4.0	4.2	4.4	4.6	4.8	5.0	5.2
log x:	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

Q.11 The velocity v of a particle at distance s from a point on its path is given by the table : 8

s ft:	0	10	20	30	40	50	60
v ft/s:	47	58	64	65	61	52	38

Estimate the time taken to travel 60 ft by using Simpson's 1/3rd rule. Compare the result with Simpson's 3/8th rule.

Q.12 The following table gives the velocity v of a particle at time t : 8

t (sec):	0	2	4	6	8	10	12
v (m/s):	4	6	16	34	60	94	136

Find the distance moved by the particle in 12 seconds and also the acceleration at time t = 2 sec

Q.13 A rocket is launched from the ground. Its acceleration is registered during the first 80 seconds and is given in the table below. Using Simpson's 1/3rd rule, find the velocity of the rocket at t = 80 seconds. 8

t (s):	0	10	20	30	40	50	60	70	80
f (cm/s^2):	30	31.63	33.34	35.47	37.75	40.33	43.25	46.69	50.67

Q.14 **Simpson's 3/8th Rule** 8

Solve all Simpson's 1/3rd problems by using Simpson's 3/8th rule.

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 6 – NUMERICAL INTEGRATION

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Gauss Quadrature Method – 2 point and 3 – point

Q.15	Evaluate $\int_{-1}^{1} \frac{dx}{1+x^2}$ using Gauss formula for n = 2 and n = 3.	8
Q.16	Using three point Gaussian quadrature formula, evaluate $\int_{0}^{1} \frac{dx}{1+x^2}$	8
Q.17	Evaluate $\int_{0}^{2} \frac{x^2+2x+1}{1+(x+1)^4}\, dx$ by Gaussian 3-point formula.	8
Q.18	Using Gaussian two-point formula compute $\int_{-2}^{2} e^{-x/2}\, dx$	8
Q.19	Evaluate $\int_{0}^{\pi} \sin x \; dx$ by using Gauss – Legendre two point formula	8
Q.20	Using three point Gaussian quadrature formula, evaluate : (i) $\int_{1}^{5} \frac{1}{x} dx$ (ii) $\int_{2}^{4} (1+x^2) dx$ (iii) $\int_{0.2}^{1.5} e^{-x^2} dx$	Each 8
Q.21	Estimate the integral $I = \int_{0}^{10} exp\left(\frac{-1}{1+x^2}\right) dx$ by Gauss quadrature with n = 2 and n = 3.	8
Q.22	Evaluate the integral $I = \int_{0}^{\pi/2} (1-0.25 sin^2 x)^{1/2}\, dx$ using Gaussian quadrature. Assume a suitable value of n.	8

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 6 – NUMERICAL INTEGRATION

SUBJECT: 302047 Numerical Methods and Optimization

COURSE : TE (2015 Pattern)

THEORY QUESTIONS

Numerical Integration : Double Integration
Trapezoidal and Simpson's Rule

Q.23 Using trapezoidal rule, evaluate $I = \int_1^2 \int_1^2 \frac{dxdy}{x+y}$ taking four sub-intervals. 8

Q.24 Evaluate $I = \int_0^1 \int_0^1 xe^y \, dxdy$ using Trapezoidal rule (h=k=0.5). 8

Q.25 Apply Trapezoidal rule to evaluate, Each 8

(i) $I = \int_1^5 \int_1^5 \frac{dxdy}{\sqrt{(x^2+y^2)}}$ taking two sub-intervals.

ii) $I = \int_0^1 \int_1^2 \frac{2xy \, dxdy}{(1+x^2)(1+y^2)}$ taking h = k = 0.25.

Q.26 Evaluate $I = \int_0^2 \int_0^2 f(x,y) \, dxdy$ trapezoidal rule for the following table:

y/x	0	0.5	1	1.5	2
0	2	3	4	5	5