Certificate Course on Numerical Methods for Engineers

Organised by
Department of Humanities & Sciences

Course Duration: 21-10-2021 to 30-11-2021

Course Coordinator: Y. Satheesh Kumar Reddy

Course Instructors: Y. Satheesh Kumar Reddy

G.Sreedhar

Dr. V. Ramachandra Reddy

K.S.R.M. COLLEGE OF ENGINEERING
(UGC-AUTONOMOUS)
Kadapa,Andhra Pradesh, India– 516 003

Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

An ISO 14001:2004 & 9001: 2015 Certified Institution

Lr. /KSRMCE/ (Humanities &Sciences)/2021-22/

Date: **14.10.2021**

To

The principal,
K.S.R.M.College of Engineering
Kadapa.

From

Y.Satheesh Kumar Reddy,
Asst. Professor of Mathematics,
Department of H&S,
K.S.R.M College of Engineering,
Kadapa.

Respected Sir,

Sub:KSRMCE - Department of H&S (Mathematics)Permission to conduct Certificate course on Numerical Methods for Engineers– Request –Reg.

With reference to the above subject, it is brought to your kind notice that, the H&S Department is planning to conduct a Certificate Course on **Numerical Methods for Engineers** for B. Tech V Sem students from **21st October 2021 to 30th November 2021**. In this regard I kindly request you sir to grant permission to conduct certificate course. This is submitted for your kind perusal.

Thanking you Sir,

Yours Faithfully
Y.Satheesh Kumar Reddy,
Asst. Professor of Mathematics,
Department of H&S,
K.S.R.M College of Engineering,
Kadapa.

Forwarded to principal sir
12/10/21 HOS

Permitted
V. S. S. Murty

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa,Andhra Pradesh, India– 516 003

Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

An ISO 14001:2004 & 9001: 2015 Certified Institution

Cr./KSRMCE/(Department of H&S)/2021-22 Date:14-10-2021

Circular

It is here by informed that the Department of H&S is going to conduct certificate course on Numerical Methods for Engineers to B.Tech V Sem Students. This certificate course starts from 21st October 2021 and ends on 30th November 2021. Interested students may register their names with the following link before 20th October 2021.

Registration Link: https://forms.gle/NN1GhErgEuDtNSQL9

For any queriesContact,

Convenor

Dr.I.Sreevani, HOD,H&S

Coordinator

Y. Satheesh Kumar Reddy, Asst. Prof, Dept. of H&S (Ph.No:8309389260)

HOD H&S

Dr. I. SREEVANI M.Sc., Ph.D.
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA - 516 005

Cc to:

The Management /Deans/HoDs/IQAC for information

NUMERICAL METHODS FOR ENGINEERS (Certificate Course)

Department of Humanities & Sciences, K.S.R.M COLLEGE OF ENGINEERING (AUTONOMOUS), Kadapa - 516005.

* Required

1. Email Id : *

2. Name of the Student : *

3. Roll No : *

4. Branch / Section : *

5. Phone Number : *

K.S.R.M.College of Engineering (UGC- Autonomous), Kadapa.
Department of Humanities & Sciences
Certificate Course on ***Numerical Methods for Engineers***
Registration List

Timestamp	Email Id	Name of the Student	Roll No	Branch / Section	Phone Number
10/14/2021 15:41:27	199y1a0598@ksrmce.ac.in	M.lakshmi narasimha reddy	199Y1A0598	Cse/b	8688112426
10/14/2021 15:41:59	maneswar14356@gmail.com	Muchukotla maneswara	199y1a05a7	Cse b/s	7569995482
10/14/2021 15:47:50	nageswarinagi123@gmail.com	P.nageswari	199Y1A05D1	Cse_c/sec	9390458137
10/14/2021 15:57:01	Kurubarajamma8@gmail.com	K. Rajamma	199y1a0566	Cse/b	9390913664
10/14/2021 16:17:37	yaparlapavani2002@gmail.com	Yaparla Pavani	199Y1A04I2	ECE-C/S	9390082187
10/14/2021 16:17:41	Saieswark8@gmail.com	K.SAI ESWAR REDDY	199Y1A0580	Cse-b/s	7893460149
10/14/2021 16:18:40	riyazuddinsyed049@gmail.com	RIYAZUDDIN SYED	199y1a05g8	CSE	8142523279
10/14/2021 16:20:01	saiprakashreddy279@gmail.com	sai prakash Reddy	199Y1AO425	A	08688144173
10/14/2021 16:20:52	199y1a04g8@Ksrmce.ac.in	U. Anuhya bhai	199Y1A04G8	Ece - c/s	7287953884
10/14/2021 16:24:12	199Y1a0437@ksrmce.ac.in	Vikas	199Y1a0437	ECE/A sec	9346147349
10/14/2021 16:26:45	Sivaaswini9@gmail.com	T. Siva thulasidhar	199Y1A04G2	ECE_C/S	9959916289
10/14/2021 16:43:54	199y1a0456@ksrmce.ac.in	Vinod jangamsetty	199y1a0456	Ece	7093582878
10/14/2021 16:50:50	rojaramanitelugu@gmail.com	T.Roja Ramani	199Y1A05G9	Cse c/s	9347063095
10/14/2021 17:07:29	199Y1A05H5@ksrmce.ac.in	V.Nithish Reddy	199Y1A05H5	Cse/ c	7993306314
10/14/2021 17:26:08	199y1a0557@ksrmce.ac.in	GUNTIKA SUDHEER	199Y1A0557	CSE/A	9347925312
10/14/2021 17:27:11	199y1a0533@ksrmce.ac.in	C.Arung	199Y1A0533	Cse A/S	6305494271
10/14/2021 17:39:38	199y1a05i3@ksrmce.ac.in	Y Vikeshkumarreddy	199y1a05i3	Cse c/s	6300941907
10/14/2021 17:40:48	199y1a0531@ksrmce.ac.in	C.Bhargavi	199Y1A0531	C.S.E-A/S	6304650163
10/14/2021 17:44:09	msr.kancharla25@gmail.com	K.Maheswar Reddy	209Y5A0502	Cse C section	6302759329
10/14/2021 17:52:20	199y1a05d8@ksrmce.ac.in	S.Reddy Sai Nitish	199Y1A05D8	CSE/C	7396154780
10/14/2021 17:56:14	199y1a0503@ksrmce.ac.in	Aluri Lakshmi Narasimha Gana	199y1a0503	CSE-A	6281166935
10/14/2021 17:58:00	209y5a0501@ksrmce.ac.in	D.chaitanya kumar reddy	209Y5A0501	CSE c/sec	6300115195
10/14/2021 18:21:51	199Y1A05I6@ksrmce.ac.in	Yeddula nandhini	199y1a05i6	Cse-c/s	8688249610
10/14/2021 18:28:05	199y1a05a6@ksrmce.ac.in	Mothukuri kirankumar	199Y1A05A6	CSE b	8639421764
10/14/2021 21:30:20	199Y1A05B4@ksrmce.ac.in	NOSSAM SAI MADHU SRI	199Y1A05B4	CSE-B/S	7893325119
10/15/2021 17:36:37	199y1A0550@ksrmce.ac.in	G. Mounika	199Y1A0550	Cse/a	6301634475
10/15/2021 18:39:58	199y1a05i1@ksrmce.ac.in	Y.nandini	199y1a05i1	Cse	9391282189
10/15/2021 19:28:01	199Y1A0520@ksrmce.ac.in	Bijivemula Lakshmi priya	199Y1A0520	CSE/A	9059379840
10/15/2021 19:53:30	199y1a05h2@ksrmce.ac.in	T. Tejaswini	199y1a05h2	CSE/c	9391309715
10/15/2021 19:53:38	guduruimran37@gmail.com	Guduru imran	199Y1A0556	CSE A	6301881013
10/15/2021 19:55:52	199Y1A05F0@ksrmce.ac.in	Shaik Suleman	199Y1A05F0	CSE C sec	9502860717
10/15/2021 19:58:41	199Y1A05D2@ksrmce.ac.in	Pommala Sandeep	199Y1A05D2	CSE C sec	6309558831
10/15/2021 20:02:47	199Y1A05I9@ksrmce.ac.in	Sai tej	199Y1A05I9	CSE C sec	9347948730
10/15/2021 20:05:13	199y1a0503@ksrmce.ac.in	Aluri Lakshmi Narasimha Gana	199y1a0503	CSE-A	6281166935
10/15/2021 20:16:40	199y1a0539@ksrmce.ac.in	Dasari Gowthami	199Y1A0539	Cse-A	7569809865
10/15/2021 20:19:03	Rahulchalla4@gmail.com	C. Rahul vardhan naidu	199Y1A0528	Cse a	9550845924
10/15/2021 20:33:36	199y1a0548@ksrmce.ac.in	GN KISHOR	199y1a0548	CSE-A/S	7095710935
10/15/2021 20:52:29	199y1a0523@krmce.ac.in	Buggana srinikhila	199y1a0523	CSE A	8978226733
10/15/2021 21:02:12	199Y1A0560@ksrmce.ac.in	G.yashoda	199Y1A0560	CSE A/sec	6305532753
10/16/2021 9:43:11	199Y1A05E7@ksrmce.ac.in	Shaik Arshad	199Y1A05E7	CSE C sec	9515963602

10/16/2021 17:51:34	prakashreddym18@gmail.com	M.PRAKASH REDDY	199Y1A0490	ECE/B	8106741081
10/16/2021 18:17:44	199y1a0582@ksrmce.ac.in	Yojitha Konapalli	199Y1A0582	CSE/B	9121924464
10/17/2021 12:58:44	199y1a0510@ksrmce.ac.in	Avula likhitha	199Y1A0510	Cse-A	8688564013
10/17/2021 13:00:01	199y1a0567@ksrmce.ac.in	K.jahnavi	199Y1A0567	Cse-b	8341453586
10/17/2021 13:01:54	199y1a0504@Ksrmce.ac.in	Aluru Lalitha	199y1a0504	Cse-A/S	8297652783
10/17/2021 13:12:14	199Y1A0572@ksrmce.ac.in	K. V. N. SHRAVANI	199Y1A0572	CSE	9391606069
10/18/2021 21:50:21	199y1a04g8@ksrmce.ac.in	U. Anuhya bhai	199Y1A04G8	Ece -c	7287953884
10/18/2021 23:12:36	209y5a0417@ksrmce.ac.in	PALLETI SUBHASH REDDY	209Y5A0417	ECE-C/S	6302492810
10/18/2021 23:12:44	209y5a0415@ksrmce.ac.in	N.Narasimha Reddy	209y5a0415	ECE-c/s	9347871365
10/19/2021 12:50:01	kotagulamohammadali@gmail.com	KOTAGULA MOHAMMAD ALI	209Y5A0203	EEE	8179294651
10/19/2021 13:56:13	199y1a0583@ksrmce.ac.in	k. pavani	199y1a0583	Cse-b	9640470067
10/19/2021 13:57:16	199y1a05c4@ksrmce.ac.in	P.SREE VAISHNAVI	199Y1A05C4	CSE-B/S	6305625221
10/19/2021 13:59:33	199y1a05a0@ksrmce.ac.in	M. POOJITHA	199Y1A05A0	Cse-b/s	9989233252
10/19/2021 15:26:31	199y1a0232@ksrmce.ac.in	Ruthesh Kumar	199y1a0232	EEE	8008669960
10/19/2021 15:27:30	199y1a0232@ksrmce.ac.in	Ruthesh Kumar	199y1a0232	EEE	8008669960
10/21/2021 11:11:55	19y1a0577@ksrmce.ac.in	K.Santosh Kumar	19y1a0577	CSE	9347606961
10/21/2021 11:21:08	199y1a057@ksrmce.ac.in	K.Santosh Kumar Reddy	199y1a0577	CSE	9347606961
10/21/2021 11:34:20	199y1a0592@ksrmce.ac.in	MALLU HARISHWAR REDDY	199y1a0592	Cse	9701632398
10/21/2021 12:46:51	199y1a04h4@ksrmce.ac.in	Vattaluru Yuvaraju	199y1a04h4	Ece/c	8522868046
10/21/2021 14:26:35	199y1a0529@ksrmce.ac.in	C. Thulasi	199Y1A0529	Cse-a	9491413185
10/21/2021 16:31:27	tasleemshaik494@gmail.com	Shaik Tasleem	199y1A05F6	Csec	8919837876
10/22/2021 11:21:46	199y1a0518@ksrmce.ac.in	B .Kavya	199Y1A0518	Cse A/s	7569748108
10/22/2021 13:59:46	199y1a0562@ksrmce.ac.in	I. Nagamani	199y1a0562	Cse-a	7993937610

Coordinator

Convenor & HOD

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA-516 005

Course Title	NUMERICAL METHODS FOR ENGINEERS (R20)	Certificate Course CSE, EEE & ECE Branches

Course Objectives:

This course would greatly benefit the students to improve their problem solving ability.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	**Solve** the equations by different methods.
CO 2	**Solve** the system of equations by different methods.
CO 3	**Apply** interpolation and approximation techniques to solve engineering problems.
CO 4	**Estimate** the numerical differentiation and integration.
CO 5	**Apply** initial value problems for solving first order differential equations.

Module I: Solution of Equations:

Solution of algebraic and transcendental equations: Bisection method, Regula-falsi method, Newton-Raphson method.

Module II: Solution of System of Equations:

Solution of linear system of equations: Gauss-Jordan method, Iterative methods of Gauss-Jacobi and Gauss-Seidel.

Module III: Interpolation and Approximation:

Interpolation with equal intervals- Newton's forward and backward difference formulae. Interpolation with unequal intervals, Lagrange's interpolation.

Module IV: Numerical Differentiation and Integration:

Numerical differentiation: Finding first and second order derivatives using Newton's formulae. Numerical integration: Newton - Cote's quadrature formulae, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.

Module V: Initial Value Problems for Ordinary Differential Equations:

Single Step methods: Taylor's series method, Euler's method, Fourth order Runge - Kutta method for solving first order equations.

Text books:

1. Numerical Methods, S Arumugam A.Thangapandi Issac, A Somasundaram SCITECH publishers, Second edition Reprint 2013.
2. Higher Engineering Mathematics, Dr. B.S Grewal, Khanna Publishers-44 edition, 2017.

Reference Books:

1. Introductory Methods of Numerical Analysis, SS Sastry, 5th edition, PHI
2. Numerical methods for Engineers and Scientists, Sharma. J.N,
3. Numerical Methods, Kandasmay,P; Thilagavathy, K; Gunavathi, K, S.Chand and Company Ltd, 2007.

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
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K.S.R.M COLLEGE OF ENGINEERING, KADAPA
(Autonomous)

Yerramasupalli, Kadapa, Andhra Pradesh – 516003

Department of Humanities & Sciences

Certification Course
On
Numerical Methods for Engineers
Schedule

Duration	Course Instructor	Topic to be covered	Timings
22-10-2021 to 27-10-2021	Sri. G.Sreedhar	**Solution of Equations:** • Bisection method • Regula-falsi method • Newton-Raphson method	**4:00 – 5:00PM**
28-10-2021 to 08-11-2021	Sri. G.Sreedhar	**Solution of Linear System of Equations:** • Gauss-Jordan method • Gauss-Jacobi iteration method • Gauss-Seidel iteration method	**4:00 – 5:00PM**
09-11-2021 to 12-11-2021	Sri. Y. Satheesh Kumar Reddy	**Interpolation with equal intervals:** • Newton's forward difference formula • Newton's backward difference formula **Interpolation with unequal intervals:** • Lagrange's interpolation	**4:00 – 5:00PM**
15-11-2021 to 18-11-2021	Sri. Y. Satheesh Kumar Reddy	**Numerical differentiation:** • Finding first and second order derivatives using Newton's formulae	**4:00 – 5:00PM**
22-112021 to 25-11-2021	Dr. V. Ramachandra Reddy	**Numerical integration:** • Newton - Cote's quadrature formulae • Trapezoidal rule • Simpson's 1/3 rule & Simpson's 3/8 rule	**4:00 – 5:00PM**
26-11-2021 to 30-11-2021	Dr. V. Ramachandra Reddy	• Taylor's series method • Euler's method • Fourth order Runge - Kutta method	**4:00 – 5:00PM**

Course Instructors: 1. Y. Satheesh Kumar Reddy 2. G. Sreedhar 3. Ramachandra Reddy

Y. Satheesh Kumar Reddy
Coordinator

Convenor & HOD

Dr. T. SREEVANI M.Sc.,,Ph.D
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA - 516 005

K.S.R.M. COLLEGE OF ENGINEERING

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Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

An ISO 14001:2004 & 9001: 2015 Certified Institution

Date: 21/10/2021

Name of the event: Certification Course on **Numerical Methods for Engineers**

Venue: **CE 204 & 205**

List of Participants

S.No	Name of the Student	Roll No	Department & Section	Contact No	Signature
1	Aluri Lakshmi Narasimha Ganapathi	199Y1A0503	CSE-A/S	6281166935	A L N Ganapathi
2	A. Lalitha	199Y1A0504	CSE-A/S	8297652783	Lalitha
3	A. Likitha	199Y1A0510	CSE-A/S	8688564013	Likhita
4	B. Kavya	199Y1A0518	CSE-A/S	7569748108	Kavya
5	B. Lakshmi Priya	199Y1A0520	CSE-A/S	9059379840	Lakshmi Priya
6	B. Sri Nikhila	199Y1A0523	CSE-A/S	9390153357	B Srinikila.
7	C. Rahul Vardhan Naidu	199Y1A0528	CSE-A/S	9550845924	C. Rahul
8	C. Thulasi	199Y1A0529	CSE-A/S	9491413185	C. Thulasi
9	C. Bhargavi	199Y1A0531	CSE-A/S	6304650163	C. Bhargavi
10	C. Aruna	199Y1A0533	CSE-A/S	8305494271	C. Aruna
11	D. Gowthami	199Y1A0539	CSE-A/S	7569809865	D. Gowthami
12	G. N. Kishor	199Y1A0548	CSE-A/S	7095710935	G. N. Kishor
13	G. Sudheer	199Y1A0557	CSE-A/Sec	9347925312	G. Sudheer
14	G. Yashoda	199Y1A0560	CSE-A/Sec	6305538753	G. Yashoda
15	I. Nagamani	199Y1A0562	CSE-A/S	7993937610	I. Nagamani
16	K. Rajamma	199Y1A0566	CSE-B/S	9390191366	K. Rajamma
17	K. Yojitha	199Y1A0582	CSE-B/S	9121924464	K. Yojitha
18	K. Pavani	199Y1A0583	CSE-B/S	9640470067	K. Pavani
19	M. Lakshmi Narasimha Reddy	199Y1A0598	CSE-B/S	8688112426	M. L. N. Reddy
20	M. Poojitha	199Y1A05A0	CSE-B/S	9989233252	M. Poojitha
21	M. Keerthana	199Y1A05A1	CSE-B	9347713052	M. Keerthana
22	N. Sai Madhu Sri	199Y1A05B4	CSE-B/S	7893325119	N. Saimadhusri
23	P. Sree Vaishnavi	199Y1A05C4	C.S.E B/S	6305625221	P. Sree vaishnavi
24	T. Tejaswini	199Y1A05H2	CSE-C/S	9391309715	T. Tejaswini
25	Y. Nandhini	199Y1A05I1	CSE-C/S	9391288189	Y. Nandini
26	Y. Nandhini	199Y1A05I6	CSE-C/S	8688249610	Y. Nandhini

Coordinator

Convenor & HOD

Dr. P. SREEVANI M.Sc.,,Ph.D.
Head of Humanities & Sciences
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KADAPA - 516 005

K.S.R.M College of Engineering (Autonomous), Kadapa

Department of Humanities & Sciences

Certification Course on Numerical Methods for Engineers

Attendance Sheet

S.No	Name of the student	Roll No	4-5 21/10/2021	4-5 22/10/2021	4-5 25/10/2021	4-6 26/10/2021	4-5 27/10/2021	4-5 28/10/2021	4-5 29/10/2021	4-5 1/11/2021	4-6 8/11/2021	4-5 9/11/2021	4-5 10/11/2021	4-6 11/11/2021	4-5 12/11/2021	4-5 15/11/2021	4-5 16/11/2021	4-6 17/11/2021	4-5 18/11/2021	4-5 22/11/21	4-5 23/11/21	4-6 24/11/21	4-5 25/11/21	4-5 26/11/21	4-6 27/11/21	4-5 29/11/21	4-5 30/11/21
1	Aluri Lakshmi Narasimha Ganapathi	199Y1A0503							—																		
2	A. Lalitha	199Y1A0504		—																							
3	A. Likhitha	199Y1A0510				—																					
4	B. Kavya	199Y1A0518							—																		
5	B.Lakshmi Priya	199Y1A0520																									
6	B . Sri Nikhila	199Y1A0523														—											
7	C. Rahul Vardhan Naidu	199Y1A0528				—																					
8	C. Thulasi	199Y1A0529														—											
9	C. Bhargavi	199Y1A0531							—		—					—											
10	C.Aruna	199Y1A0533							—							—											
11	D. Gowthami	199Y1A0539														—											
12	G. N. Kishor	199Y1A0548																									
13	G.Sudheer	199Y1A0557										—															
14	G. Yashoda	199Y1A0560						—				—															
15	I. Nagamani	199Y1A0562									—																
16	K. Rajamma	199Y1A0566																									
17	K.Yojitha	199Y1A0582						—																			
18	K. Pavani	199Y1A0583						—																			
19	M. Lakshmi Narsimha Reddy	199Y1A0598												—													
20	M. Poojitha	199Y1A05A0															—										
21	M.keerthana	199Y1A05A1																									
22	N. Sai Madhu Sri	199Y1A05B4															—										
23	P Sree Vaishnavi	199Y1A05C4																									
24	T. Tejaswini	199Y1A05H2														—											
25	Y. Nandhini	199Y1A05I1	—																								
26	Y. Nandhini	199Y1A05I6	—																								
27																											
	Signature of Instructor																										

Coordinator

Convenor & HOD

Dr. I. SREEVANI M.Sc., Ph.D.
Head of Humanities & Sciences
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K.S.R.M. COLLEGE OF ENGINEERING

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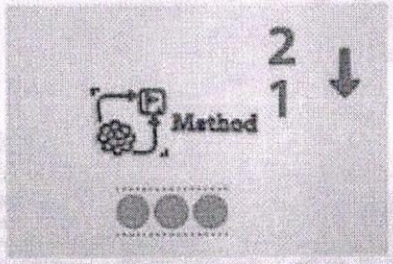
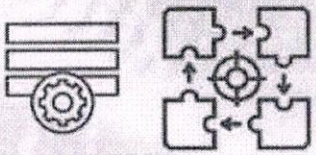
Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

KSNR
lives on..

Department of Humanities & Sciences

Certificate Course on
Numerical Methods for Engineers





Coordinator
Y.Satheesh Kumar Reddy

Course Instructors
Y.Satheesh Kumar Reddy
G.Sreedhar
Dr.V.Ramachandra Reddy

Date From 21/10/2021 to 30/11/2021 **Venue: CE 204 & 205**

For V sem EEE, ECE & CSE Students

DR. J.SREEVANI DR. V.S.S. MURTHY PROF. A. MOHAN DR. KANDULA CHANDRA OBUL REDDY SMT. K. RADHESWARI SRI K. MADAN MOHAN REDDY SRI K. RAJA MOHAN REDDY

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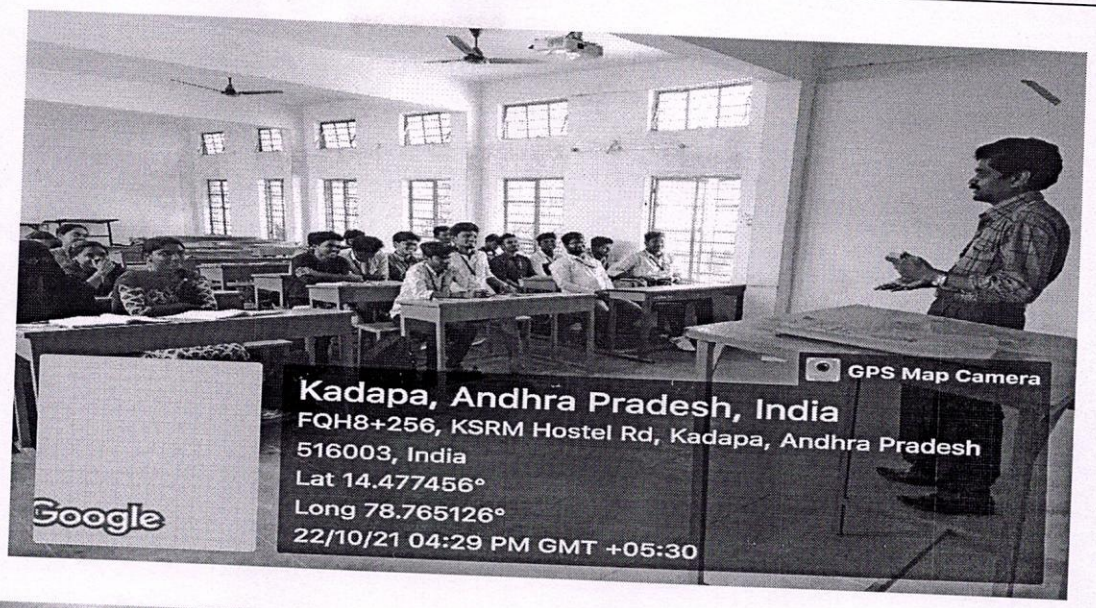
ACTIVITY REPORT

Certification Course
on
"NUMERICAL METHODS FOR ENGINEERS"

21st October 2021 to 30th November 2021

Name of the Activity	Certification Course on "NUMERICAL METHODS FOR ENGINEERS"
Type of Activity	Student Centric Activity
Date & Time of Activity	21.10.2021 – 30.11.2021
Details of Participants	Students (26)
Coordinator(s)	Y. Satheesh Kumar Reddy
Organizing Dept./ Support system	Department of Humanities and Sciences
Description	Certification course on Numerical Methods for Engineers was organized by Department of Humanities and Sciences from 21st October 2021 to 30th November 2021. Sri, Y. Satheesh Kumar Reddy, Sri. G. Sridhar and Dr. V. Ramachandra Reddy acted as course instructors. The main aim of the course is to create awareness among students on different Numerical Methods which can be utilized when analytical methods fail. The numerical methods are used for deeper understanding to predict the anomalies which are not possible in the analytical methods because the analytical method can solve only two or three unknown variables but numerical methods can do much more than it very accurately. Numerical methods are defined as "techniques by which mathematical problems are formulated so they may be solved with arithmetic operations". Many of these techniques have great importance in engineering and are vital in the development of finite element theory and other "high end" topics. 5 weeks course was successfully completed and course completion certificate were provided to the participants.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FQH8+256, KSRM Hostel Rd, Kadapa, Andhra Pradesh
516003, India
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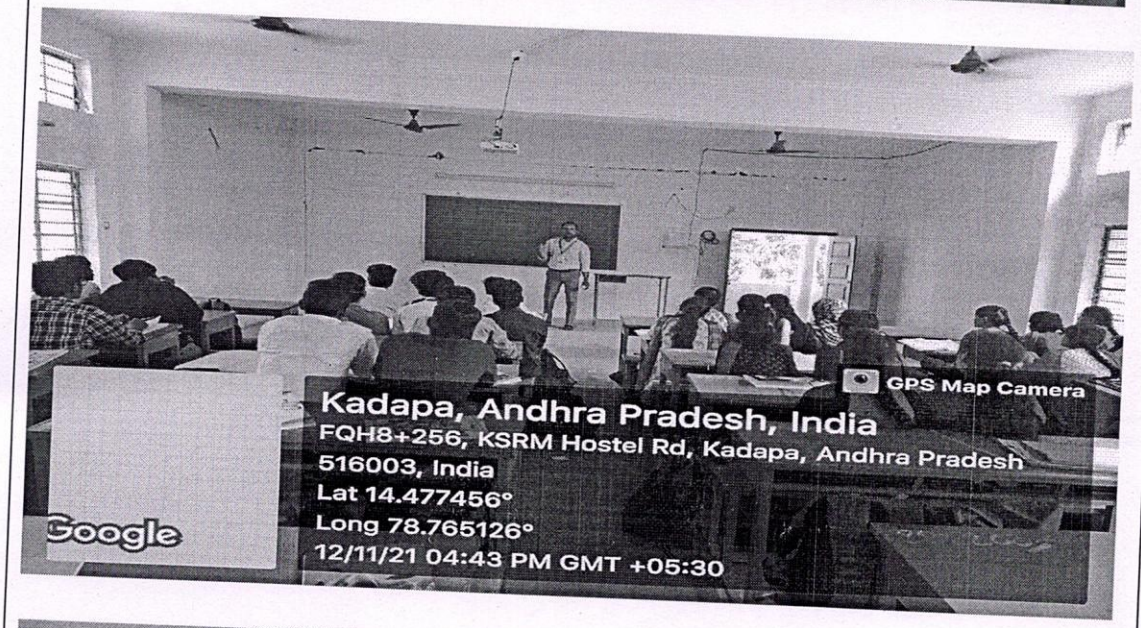
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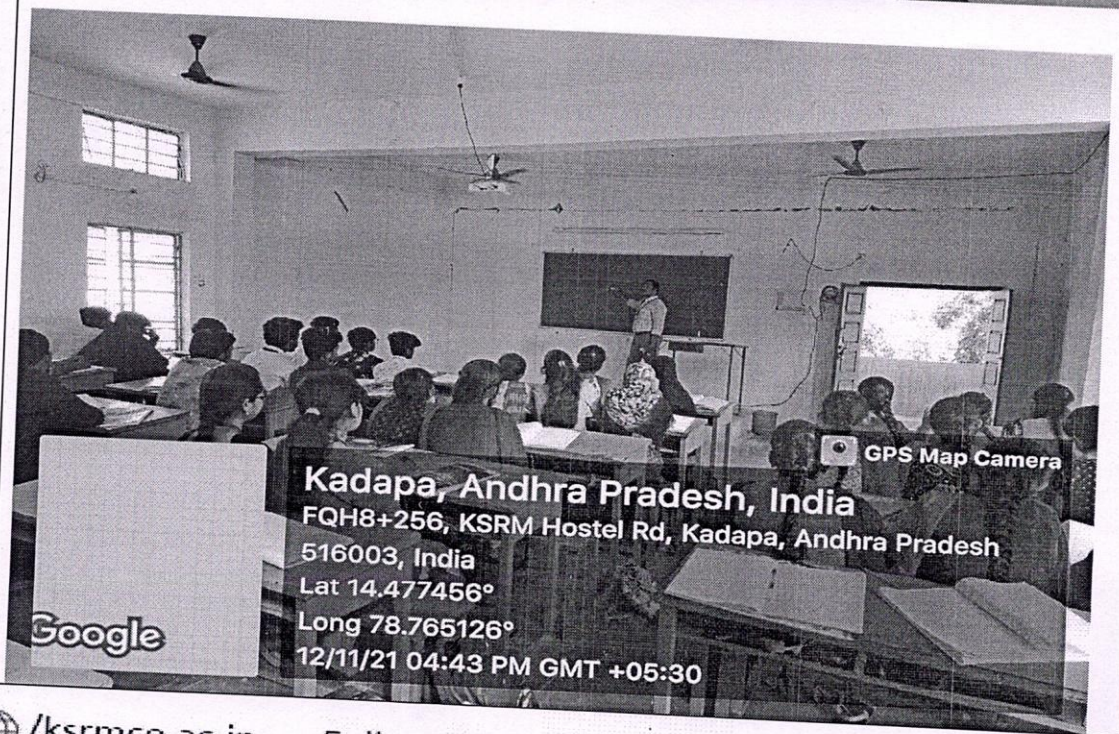
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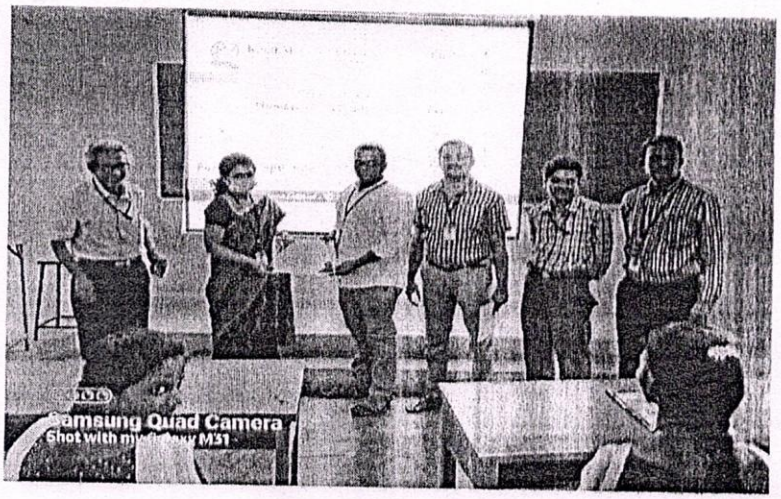

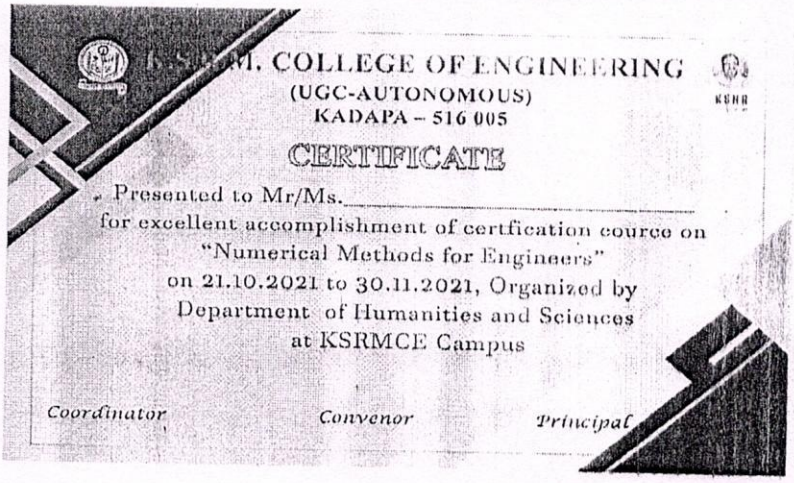

K.S.R.M. COLLEGE OF ENGINEERING
(UGC-AUTONOMOUS)
KADAPA – 516 005

CERTIFICATE

Presented to Mr/Ms._____
for excellent accomplishment of certfication cource on
"Numerical Methods for Engineers"
on 21.10.2021 to 30.11.2021, Organized by
Department of Humanities and Sciences
at KSRMCE Campus

Coordinator *Convenor* *Principal*

Coordinator

Convenor & HOD

Dr. I. SREENIVASULU, M.Sc., Ph.D.
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA - 516 005

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

KADAPA – 516 005

CERTIFICATE

This is to certify that ~~Mr~~/Ms. G. Yashoda bearing the Roll.No: 19Y1A0560 has successfully completed certificate course on

"NUMERICAL METHODS FOR ENGINEERS"

from 21 st October ,2021 to 30 th November, 2021 Organized by Faculty of Mathematics, Department of Humanities and Sciences, KSRMCE, Kadapa.

Coordinator

Convenor&HOD

V.S.S. Murty

Principal

K.S.R.M. COLLEGE OF ENGINEERING

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This is to certify that ~~Mr~~/Ms. P. Sree Vaishnavi bearing the Roll.No: 19Y1A05C4 has successfully completed certificate course on

"NUMERICAL METHODS FOR ENGINEERS"

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K.S.R.M. COLLEGE OF ENGINEERING

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CERTIFICATE

This is to certify that Mr/~~Ms~~. G. Sudheer bearing the Roll.No: 19Y1A0557 has successfully completed certificate course on

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Coordinator

Convenor&HOD

V.S.S. Murthy
Principal

K.S.R.M.COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA.

FEEDBACK FORM FOR NUMERICAL METHODS FOR ENGINEERS

* Required

1. Name of the Student : *

2. Roll No : *

3. Semester : *

Mark only one oval.

Option 1

4. Branch / Section : *

5. Email Id : *

6. Phone Number : *

Feedback Form on NME

Questionnaire for ECE & CSE Branches (V Sem)

7. 1) Is the course content met your expectations. *

Mark only one oval.

- a) Strongly Agree
- B) Agree
- C) Some what Agree
- D) Disagree

8. 2) Is the lecture sequence planned well ? *

Mark only one oval.

- a) Strongly Agree
- b) Agree
- c) Some what Agree
- d) Disagree

9. 3) The instructors explained the course with relative examples. *

Mark only one oval.

- a) Yes
- b) Some what
- c) Try
- d) Cannot

10. 4) Are you exposed to the new knowledge from this course? *

Mark only one oval.

- a) Yes
- b) Some what
- c) Try
- d) Cannot

11. 5) Rate the knowledge of the course instructors in providing the expected outcomes on a 4 point Scale. *

Mark only one oval.

- a) 4
- b) 3
- c) 2
- d) 1

12. 6) Rate the value of the course in increasing your skills on a 4 point scale. *

Mark only one oval.

- a) 4
- b) 3
- c) 2
- d) 1

13. 7) Any Suggestions / Give comments on the Course. *

K.S.R.M.College of Engineering (UGC- Autonomous), Kadapa.

Department of Humanities & Sciences

Certificate Course on ***Numerical Methods for Engineers***

Feedback Responses

Timestamp	Name of the Student :	Roll No :	Semester :	Branch / Section :	Email Id :	Phone Number :	1) Is the course content met your expectations.	2) Is the lecture sequence planned well ?	3) The instructors explained the course with relative examples.	4) Are you exposed to the new knowledge from this course?	5) Rate the knowledge of the course instructors in providing the expected outcomes on a 4 point Scale.	6) Rate the value of the course in increasing your skills on a 4 point scale.	7) Any Suggestions / Give comments on the Course.
12/6/2021 12:11:43	Konapalli.Yojitha	199Y1A0582	Option 1	CSE-B/s	199y1a0582@ksrmce.ac.in	9121924464	B) Agree	b) Agree	a) Yes	a) Yes	a) 4	a) 4	No
12/6/2021 17:31:55	K. Rajamma	199y1a0566	Option 1	Cse/B	Kurubarajamma8@gmail.com	9390913664	C) Some what Agree	c) Some what Agree	d) Cannot	d) Cannot	d) 1	b) 3	Yes
12/6/2021 20:49:29	P.SREE VAISHNAVI	199Y1A05C4	Option 1	CSE-B	199y1a05c4@ksrmce.ac.in	6305625221	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Nothing
12/8/2021 11:25:26	k. pavani	199y1a0583	Option 1	Cse_B	199y1a0583@ksrmce.ac.in	9640470067	B) Agree	a) Strongly Agree	a) Yes	a) Yes	b) 3	b) 3	good
12/10/2021 14:33:50	Masala poojitha	199Y1A05A0	Option 1	Cseb	199Y1a05a0@ksrmce.ac.in	9989233252	a) Strongly Agree	a) Strongly Agree	b) Some what	a) Yes	a) 4	b) 3	Ntg
12/13/2021 17:50:32	B.kavya	199Y1A0518	Option 1	Cse A/s	199y1a0518@ksrmce.ac.in	7569748108	B) Agree	a) Strongly Agree	a) Yes	a) Yes	b) 3	b) 3	It was an amazing experience to join in this course
12/13/2021 17:51:10	C. Rahul vardhan naidu	199Y1A0528	Option 1	Cse_a	199Y1A0528@ksrmce.ac.in	9550845924	B) Agree	b) Agree	b) Some what	a) Yes	b) 3	b) 3	Complete the course with nest sequence
12/13/2021 17:51:45	Avula likhitha	199Y1A0510	Option 1	Cse-A	199y1a0510@ksrmce.ac.in	8688564013	B) Agree	b) Agree	a) Yes	b) Some what	a) 4	b) 3	No
12/13/2021 17:52:15	C.Bhargavi	199Y1A0531	Option 1	C.S.E/A SEC	199y1a0531@ksrmce.ac.in	6304650163	B) Agree	b) Agree	a) Yes	a) Yes	b) 3	b) 3	Good
12/13/2021 17:54:26	G N KISHOR	199y1a0548	Option 1	CSE-A/S	199y1a0548@ksrmce.ac	7095710935	B) Agree	b) Agree	a) Yes	a) Yes	b) 3	b) 3	Nill
12/13/2021 17:56:45	K. Rajamma	199y1a0566	Option 1	Cse B/s	199y1a0566@ksrmce.ac.in	9390913664	B) Agree	b) Agree	c) Try	b) Some what	b) 3	b) 3	Yes
12/13/2021 17:58:31	Chandra. Thulasi	199Y1A0529	Option 1	CSE-A	199y1a0529@ksrmce.ac.in	9491413185	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Nothing
12/13/2021 18:01:46	Konapalli Yojitha	199Y1A0582	Option 1	CSE- B/s	199y1a0582@ksrmce.ac.in	9121924464	B) Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	No comments
12/13/2021 18:05:53	M. Poojitha	199Y1A05A0	Option 1	Cse b	199Y1A05A0@ksrmce.ac.in	9989233252	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	d) 1	d) 1	Ntg
12/13/2021 18:06:25	M.lakshmi narasimha re	199y1a0598	Option 1	Cse/b	199y1a0598@ksrmce.ac.in	8688112426	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Better to conduct more such events for us..
12/13/2021 18:08:26	I. Nagamani	199y1a0562	Option 1	CSE-A	199y1a0562@ksrmce.ac.in	7993937610	B) Agree	b) Agree	a) Yes	a) Yes	b) 3	b) 3	Good
12/13/2021 18:08:40	T. Tejaswini	199y1a05h2	Option 1	CSE c	199y1a05h2@ksrmce.ac.in	9391309715	B) Agree	b) Agree	b) Some what	b) Some what	b) 3	b) 3	All is good
12/13/2021 18:10:08	C.Aruna	199Y1A0533	Option 1	Cse A/S	charuna202002@gmail.com	6305494271	B) Agree	b) Agree	a) Yes	b) Some what	b) 3	b) 3	Gud
12/13/2021 18:17:32	Biivemula Lakshmi Priy	199Y1A0520	Option 1	CSE/A	199Y1A0520@ksrmce.ac.in	9059379840	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	No
12/13/2021 18:24:24	MEDEPALLI KEERTHA	199Y1A05A1	Option 1	CSE/B	199y1a05a1@ksrmce.ac.in	9347713052	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	b) 3	Nothing
12/13/2021 18:27:22	P.SREE VAISHNAVI	199Y1A05C4	Option 1	CSE-B	199y1a05c4@ksrmce.ac.in	6305625221	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Nothing
12/13/2021 18:27:59	Buggana srinikhila	199y1a0523	Option 1	CSE A	199y1a0523@ksrmce.ac.in	9390153357	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Nothing
12/13/2021 19:28:27	k. Pavani	199y1a0583	Option 1	CSE-B	199y1a0583@ksrmce.ac.in	9640470067	B) Agree	b) Agree	a) Yes	a) Yes	b) 3	b) 3	very helpful to us
12/13/2021 21:02:46	ALURU LALITHA	199Y1A0504	Option 1	CSE -A/S	199y1a0504@Ksrmce.ac.in	8297652783	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Nothing
12/13/2021 21:03:57	NOSSAM SAI MADHU	199Y1A05B4	Option 1	CSE-B/S	199Y1A05B4@ksrmce.ac.in	7893325119	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	No suggestions
12/13/2021 22:21:46	G.yashoda	199y1a0560	Option 1	CSE,A/sec	199Y1A0560@ksrmce.ac.in	6305532753	a) Strongly Agree	a) Strongly Agree	a) Yes	a) Yes	a) 4	a) 4	Good

Coordinator

Convenor & HOD

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K.S.R.M College of Engineering
KADAPA

INTRODUCTION

Mathematical models for a wide variety of problems in science and engineering can be formulated into equations of the form $f(x) = 0$, where x and $f(x)$ may be real, complex or vector quantities.

The solution process often involves finding the values of x that would satisfy the above equation. These values are called the roots of the equation. Since the function $f(x)$ becomes zero at these values, they are also known as zeros of the function $f(x)$.

The above equation may belong to any one of the following types:

(1) Algebraic equations
(2) Polynomial equations
(3) Transcendental equations.

Any function of one variable which does not graph as a straight line in two dimensions (or) any function of two variables which does not graph as a plane in three dimensions can be said to be non-linear.

Let us consider the function $y = f(x)$. If $f(x)$ is a linear function then the dependent variable y changes in direct proportion to any change in the independent variable x.

Ex: $y = 2x+9$ is a linear function.

On the other hand the function $y = f(x)$, is said to be non- linear function if the changes in dependent variable y is not in direct or exact proportion to the changes in the independent variable x.

Ex: $y = 4x^2+9$ is a non- linear function.

Algebraic equation: An equation of the type $y = f(x)$ is said to be algebraic if it can be expressed in the form $f_n y_n + f_{n-1} y_{n-1} + \cdots + f_1 y_1 + f_0 = 0$ where f_i is an i^{th} order polynomial in x. The above equation can be represented as a general form of $f(x, y) = 0$. These equations have an infinite number of pairs of values x and y which satisfy them.

Polynomial equations: Polynomial equations are a simple class of algebraic equations which are represented as $a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0 = 0$

This is called n^{th} degree equation in x and it has n roots.

The roots may be (i) Real and different

(ii) Real and equal

(iii) Complex numbers.

Transcendental equations: A non- algebraic equation is called a transcendental equation. These include trigonometric, exponential and logarithmic functions. A transcendental equation may have a finite (or) an infinite number of real roots (or) may not have real roots at all.

Methods of solution: There are a number of ways to find the roots of linear and non-linear equations. They include (1) Direct analytical methods

(2) Graphical method

(3) Trial and error methods

(4) Iterative methods.

- Direct analytical methods for solving non-linear equations do not exist except for certain simple cases.
- Graphical methods are useful when we are satisfied with approximate solution for a problem. These methods involve plotting the given function and determining the points where it crosses the X-axis. These points represent approximate values of the roots of the function (or) equation.
- Trial and error method involves a series of initial approximations for x and each time evaluating the function to see whether it is close to zero (or) not.

Although graphical, trial and error methods provide satisfactorily approximations for many problems sometimes they become laborious and time consuming. Moreover, the accuracy of the results is inadequate for the requirements of many engineering and scientific problems. With the advent of computers algorithmic approaches known as iterative methods have became popular.

An iterative technique usually begins with an approximate value of the root known as the initial approximation and then it is successively corrected iteration by iteration. The process of iteration stops when the desired level of accuracy is obtained. Since, the iterative methods involve a large number of steps and arithmetic operations to reach a solution. The use of computers has become inevitable to make the task simple and efficient.

Iterative methods: There are a number of iterative methods that have been tried and used successfully in various problem situations. All these methods typically generate a sequence of estimates of the solution which is expected to converge to the actual solution. All the iterative methods begin their process of solution with one (or) more initial approximations.

Based on the number of initial approximations they can be categorized as

(i) Bracketting methods (ii) Open-end methods.

Bracketting methods: These are also called as interpolation methods. These methods start with two initial approximations that bracket the root and then systematically reduce the width of the bracket until the solution is reached. These methods are based on the assumption that

MODULE I: Solution of Equations

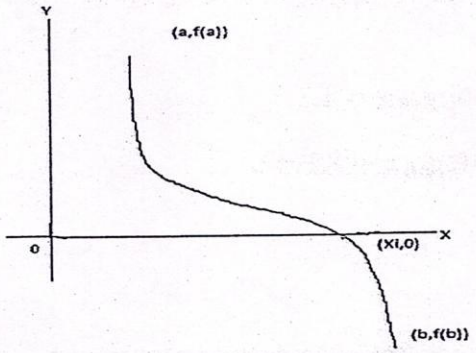
BISECTION METHOD

This is also called as Bolzano's method (or) Interval halving method.

Let $y \equiv f(x) = 0$ be the given equation and $[a, b]$ be the interval so that $f(a)$ and $f(b)$ are of opposite signs. Without loss of generality, we assume that $f(a)$ is positive and $f(b)$ is negative then the root lies between a and b.

Let its approximate value is given by $x_i = \frac{a+b}{2}$

If $f(x_i) = 0$, we conclude that x_i is a root of the equation $f(x) = 0$. Otherwise the root lies between either a and x_i (or) x_i and b depending upon whether $f(x_i)$ is negative (or) positive. Now search for the root is made in the new interval which is half of the previous interval. By repeating this procedure the root is found to the desired level of accuracy.



The bisection method is simple but the convergence is very slow. The interval within which the root lies is bisected each time until we get the root with desired level of accuracy.

PROBLEMS:

1. **By using the bisection method, find an approximate root of the equation $sinx = \frac{1}{x}$ that lies between $x = 1$ and $x = 1.5$ (measured in radians). Carry out computations upto the 7th stage.**

Solution: Given equation is $sinx = \frac{1}{x}$

$$\Rightarrow x\ sinx = 1$$

$$\Rightarrow x\ sinx - 1 = 0$$

Here $f(x) = x\ sinx - 1$

Given that a =1 and b = 1.5

$f(1) = -0.1585\ (-ve)$ $\qquad$ $f(1.5) = 0.4962\ (+ve)$

By the bisection method, the approximate root is given by $x_i = \frac{a+b}{2}$

Iteration Number	a	b	$x_i = \frac{a+b}{2}$	$f(x_i)$
Initial	1	1.5	1.2500	0.1862
1	1	1.25	1.1250	0.0151
2	1	1.125	1.0625	- 0.0718
3	1.0625	1.125	1.0938	- 0.0283
4	1.0938	1.125	1.1094	- 0.0066
5	1.1094	1.125	1.1172	0.0042
6	1.1094	1.1172	1.1133	

Hence the required approximate root at 7^{th} stage is 1.1133 corrected to 4 decimal places.

2. **Find the root of the equation $x \log_{10} x = 1.2$ which lies between 2 and 3 correct to four decimal places.**

Solution: Given equation is $x \log_{10} x = 1.2$

$$\Rightarrow x \log_{10} x - 1.2 = 0$$

Here $f(x) = x \log_{10} x - 1.2$

Given that $a = 2$ and $b = 3$

$f(2) = -0.5979\ (-ve)$ $\qquad$ $f(3) = 0.2314\ (+ve)$

By the bisection method, the approximate root is given by $x_i = \frac{a+b}{2}$

Iteration Number	a	b	$x_i = \frac{a+b}{2}$	$f(x_i)$
Initial	2	3	2.5000	- 0.2051
1	2.5	3	2.7500	0.0082
2	2.5	2.75	2.6250	- 0.0998
3	2.6250	2.75	2.6875	- 0.0461
4	2.6875	2.75	2.7188	- 0.0190
5	2.7188	2.75	2.7344	- 0.0054
6	2.7344	2.75	2.7422	0.0014
7	2.7344	2.7422	2.7383	- 0.0020
8	2.7383	2.7422	2.7402	- 0.0004
9	2.7402	2.7422	2.7412	0.0005
10	2.7402	2.7412	2.7407	

Hence the required approximate root is 2.7407 corrected to 4 decimal places.

MODULE II: SOLUTION OF SYSTEM OF EQUATIONS

We come across very often simultaneous linear equations especially in the fields of Science and Engineering. Our problem is to solve the system of equations. In lower classes, we have solved such equations by using Cramer's rule (or) by matrix methods.

These methods become complicated when the number of unknowns in the system is large. After the availability of computers, we are trying with numerical methods which are suited for computer operations. These numerical methods are of two types namely

(i) Direct methods
(ii) Iterative methods.

Direct Methods:

The direct methods which are used to solve the system of equations are Gauss elimination method and its modification, Gauss-Jordan method, Factorization methods etc.,

Gauss – Jordan Method: In this method the unknowns are eliminated so that the system is in diagonal form i.e., each equation involving one unknown. From these equations the unknowns can be obtained easily.

PROBLEMS

1. **Solve the equations $x+y+z=9, 2x-3y+4z=13$ and $3x+4y+5z=40$ by Gauss – Jordan method.**

Solution: Given equations are $x+y+z=9$

$$2x-3y+4z=13$$

$$3x+4y+5z=40$$

The augmented matrix of the given system is $[A:B]=\begin{bmatrix}1 & 1 & 1 & 9\\ 2 & -3 & 4 & 13\\ 3 & 4 & 5 & 40\end{bmatrix}$

$$\left.\begin{matrix}R_2 \to R_2-2R_1\\ R_3 \to R_3-3R_1\end{matrix}\right\} \sim \begin{bmatrix}1 & 1 & 1 & 9\\ 0 & -5 & 2 & -5\\ 0 & 1 & 2 & 13\end{bmatrix}$$

$$R_3 \to 5R_3+R_2 \sim \begin{bmatrix}1 & 1 & 1 & 9\\ 0 & -5 & 2 & -5\\ 0 & 0 & 12 & 60\end{bmatrix}$$

$$\frac{R_3}{12} \sim \begin{bmatrix}1 & 1 & 1 & 9\\ 0 & -5 & 2 & -5\\ 0 & 0 & 1 & 5\end{bmatrix}$$

$$R_1 \to 5R_1 + R_2 \sim \begin{bmatrix} 5 & 0 & 7 & 40 \\ 0 & -5 & 2 & -5 \\ 0 & 0 & 1 & 5 \end{bmatrix}$$

$$\left.\begin{matrix} R_1 \to R_1 - 7R_3 \\ R_2 \to R_2 - 2R_3 \end{matrix}\right\} \sim \begin{bmatrix} 5 & 0 & 0 & 5 \\ 0 & -5 & 0 & -15 \\ 0 & 0 & 1 & 5 \end{bmatrix}$$

$$\left.\begin{matrix} \frac{R_1}{5}, \frac{R_2}{-5} \end{matrix}\right\} \sim \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 5 \end{bmatrix}$$

$\therefore x = 1, y = 3, z = 5$ is the required solution.

2. **Solve the equations $10x + y + z = 12, 2x + 10y + z = 13$ and $x + y + 5z = 7$ by Gauss – Jordan method.**

Solution: Given equations are $10x + y + z = 12$

$$2x + 10y + z = 13$$

$$x + y + 5z = 7$$

The augmented matrix of the given system is $[A : B] = \begin{bmatrix} 10 & 1 & 1 & 12 \\ 2 & 10 & 1 & 13 \\ 1 & 1 & 5 & 7 \end{bmatrix}$

$$\left.\begin{matrix} R_2 \to 5R_2 - R_1 \\ R_3 \to 10R_3 - R_1 \end{matrix}\right\} \sim \begin{bmatrix} 10 & 1 & 1 & 12 \\ 0 & 49 & 4 & 53 \\ 0 & 9 & 49 & 58 \end{bmatrix}$$

$$R_3 \to 49R_3 - 9R_2 \sim \begin{bmatrix} 10 & 1 & 1 & 12 \\ 0 & 49 & 4 & 53 \\ 0 & 0 & 2365 & 2365 \end{bmatrix}$$

$$\frac{R_3}{2365} \sim \begin{bmatrix} 10 & 1 & 1 & 12 \\ 0 & 49 & 4 & 53 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\left.\begin{matrix} R_1 \to R_1 - R_3 \\ R_2 \to R_2 - 4R_3 \end{matrix}\right\} \sim \begin{bmatrix} 10 & 1 & 0 & 11 \\ 0 & 49 & 0 & 49 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\frac{R_2}{49} \sim \begin{bmatrix} 10 & 1 & 0 & 11 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$R_1 \to R_1 - R_2 \sim \begin{bmatrix} 10 & 0 & 0 & 10 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\frac{R_1}{10} \sim \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$\therefore x = 1, y = 1, z = 1$ is the required solution.

MODULE 3

INTERPOLATION

Chapter Objectives

- Introduction
- Forward and Backward Differences
- Newton's forward interpolation formula
- Newton's backward interpolation formula
- Interpolation with unequal intervals
- Lagrange's interpolation formula
- Inverse interpolation
- Lagrange's method
- Iterative Method
- Objective type of Questions

Introduction

Suppose we are given the following values of $y = f(x)$ for a set of valuesof x:

x:	x_0	x_1	$x_2 \cdots x_n$
y:	Y_0	y_1	$y_2 \cdots y_n$.

Then the process of finding the value of y corresponding to any value of $x = x_i$ between x_0 and x_n is called *interpolation*. Thus *interpolation is the technique of estimating the value of a function for any intermediate value of the independent variable* while the process of computing the value of the function outside the given range is called *extrapolation*. The term interpola- tion however, is taken to include extrapolation.

If the function $f(x)$ is known explicitly, then the value of y correspond-ing to any value of x can easily be found. Conversely, if the form of $f(x)$ is not known (as is the case in most of the applications), it is very difficult to de-termine the exact form of $f(x)$ with the help of tabulated set of values (x_i, y_i). In such cases, $f(x)$ is replaced by a simpler function $\cdot(x)$ which assumes the same values as those of $f(x)$ at the tabulated set of points. Any other value may be calculated from $\cdot(x)$ which is known as the *interpolating function* or *smoothing function*. If $\cdot(x)$ is a polynomial, then it called the *interpolating polynomial* and the process is called the *polynomial interpolation*. Similarly when $\cdot(x)$ is a finite trigonometric series, we have trigonometric interpola-tion. But we shall confine ourselves to polynomial interpolation only.

The study of interpolation is based on the calculus of finite differences. We begin by deriving two important *interpolation formulae* by means of forward and backward differences of a function. These formulae are often employed in engineering and scientific investigations.

Difference Operators :

We introduce two difference operators namely forward and backward difference operators.

Forward Differences:

Consider the function $y = f(x)$. Suppose we are given a table of values of the function at the points $x_0, x_1 = x_0 + h, x_2 = x_0 + 2h, \ldots x_n = x_0 + nh$. Let $y_0 = f(x_0), y_1 = f(x_1), y_2 = f(x_2) \ldots y_n = f(x_n)$.

We define $\Delta f(x) = f(x + h) - f(x)$

Thus $\Delta y_0 = f(x_0 + h) - f(x_0) = y_1 - y_0$

Similarly, $\Delta y_1 = y_2 - y_1, \Delta y_2 = y_3 - y_2, \ldots\ldots \Delta y_{n-1} = y_n - y_{n-1}$.

Δ is called the *forward difference operator* and $\Delta y_0, \Delta y_1, \Delta y_2 \ldots \Delta y_n$ are the *first forward differences of the function* $y = f(x)$.

The second order differences of the function are defined by

$\Delta^2 y_0 = \Delta y_1 - \Delta y_0, \Delta^2 y_1 = \Delta y_2 - \Delta y_1, \Delta^2 y_2 = \Delta y_3 - \Delta y_2, \ldots\ldots \Delta^2 y_{n-1} = \Delta y_n - \Delta y_{n-1}$.

In a similar manner higher order differences can be defined. In general the n^{th} differences are defined by $\Delta^n y_i = \Delta^{n-1} y_{i+1} - \Delta^{n-1} y_i$

These differences of the function $y = f(x)$ can be systematically represented in the form of a table called *forward difference table*. We can construct the difference table for any number of arguments and sample difference table is given for four conjugative arguments.

Forward difference table:

x	y.	Δy	Δ^2y	Δ^3y
x_0	y_0			
		Δy_0		
x_1	y_1		$\Delta^2 y_0$	
		Δy_1		$\Delta^3 y_0$

Intial and Boundary Conditions:

An ordinary differential equation of n^{th} order is of the form $F\left(x, y, \frac{dy}{dx}, \frac{d^2y}{dx^2}, \ldots, \frac{d^ny}{dx^n}\right) = 0 \longrightarrow (2)$

Its general solution will contain n arbitrary constants and it will be of the form $f(x, y, c_1, c_2, \ldots c_n) = 0 \longrightarrow (3)$

To obtain its Particular solution, n conditions must be given so that the constants $c_1, c_2, \ldots c_n$ can be determined. Problems in which $y, y', \ldots y^{(n-1)}$ are all specified at the same value of x, say x_0, are called intial-value Problems. If the conditions on y are Prescribed at n distinct points, then the problems are called boundary-value Problems. Problems in which function is Prescribed at k different points and $(n-k)$ derivatives are Prescribed at the same point are called mixed Value Problems.

1. Taylor-Series Method:-

Consists of expanding the function $y(x)$ in powers of $(x - x_0)$:

$$y(x) = y(x_0) + y'(x_0)\cdot(x-x_0) + \frac{y''(x_0)}{2!}(x-x_0)^2 + \frac{y'''(x_0)}{3!}(x-x_0)^3 + \cdots + \frac{y^{(n)}(x_0)}{n!}(x-x_0)^n + \cdots\cdots$$

If we let $x - x_0 = h$ (i.e $x = x_1 = x_0 + h$), we can write the Taylor's Series as

$$y(x) = y(x_0) + \frac{h}{1!}y'(x_0) + \frac{h^2}{2!}y''(x_0) + \frac{h^3}{3!}y'''(x_0) + \cdots$$

i.e $$y(x) = y_0 + \frac{h}{1!}y_0' + \frac{h^2}{2!}y_0'' + \frac{h^3}{3!}y_0''' + \cdots \longrightarrow (4)$$

In (3), $y(x_0)$ is known, from Intial condition. The remaining coefficients $y'(x_0), y''(x_0), \ldots y^{(n)}(x_0)$ etc are obtained by successively differentiating (1) and evaluating at x_0. Substituting these values in (4), $y(x)$ at any point can be

Unit - V

Intial Value Problems for ordinary differential equations:

Solution of a Differential Equation:-

The solution of an ordinary differential equation in which x is the independent variable and y is the dependent variable usually means finding an explicit expression for y interms of a finite number of element -ary functions of x; for example, polynomial, trigono -metric or exponential functions. If such explicit relation is found, then the solution is known as the closed form (or) finite form of solution. In the absence of such a solution, we have to resort to numerical methods of solution.

In this chapter we mainly concentrate on the numerical solution of ordinary differential equations and discuss the following methods

1. Taylor's series method
2. Euler's method
3. Fourth order Runge-Kutta method

To describe various numerical methods for the solution of ordinary differential equations.

We consider the general first order differential equation,

$$\frac{dy}{dx} = f(x, y) \quad \text{---} (1)$$ with the intial condition $y(x_0) = y_0$

In these methods, y in (1) is approximated by a truncated series, each term of which is a function of x. The information about the curve at one point is utilized and solution is not iterated. As such, these are refe -rred to as Single-Step methods.