Certificate Course

On

MATLAB for Beginners

Faculty Coordinators: Smt.S.Sharmila Banu

Miss S.Jabeen

Duration: **09/11/2020 to 21/11/2020**

K.S.R.M. COLLEGE OF ENGINEERING

(UGC - AUTONOMOUS)
Kadapa, Andhra Pradesh, India - 516003

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

An ISO 14001:2004 & 9001: 2015 Certified Institution

Lr./KSRMCE/ (Department of ECE)/2020-21

Date: 04/11/2020

To
The Principal
KSRM College of Engineering
Kadapa, AP.

Sub: KSRMCE - (Department of ECE) – Permission to conduct certification course on MATLAB for Beginners Request-Reg.

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Respected Sir,

With reference to the cited, the Department of ECE is planning to conduct a certification course on MATLAB for Beginners for B.Tech V SEM ECE students from 09.11.2020 to 21.11.2020 in online mode. In this regard, we kindly request you to grant permission to conduct certification course. This is submitted for your kind perusal.

Thanking you sir,

Yours Faithfully,

Coordinators,
Smt. S. Sharmila Banu
Miss.S.Jabeen

Forwarded to the Principal Sir

Cc:

To The Director for Information

To All Deans/HODs

Permitted
U.S.S. Murty
PRINCIPAL
K.S.R.M. COLLEGE OF ENGINEERING
KADAPA - 516 003. (A.P.)

K.S.R.M. COLLEGE OF ENGINEERING

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Date: 04/11/2020

Circular

All the B.Tech V SEM ECE students are hereby informed that department of ECE is going to conduct 30 hours certification course on MATLAB for Beginners from 09/11/2020 to 21/11/2020. Interested students may register their names with following link on or before 07/11/2020.

Registration Link: https://forms.gle/YVmRhnPbktsRknVu8

For any queries contact,

Coordinators

Smt. S. Sharmila Banu, Assistant Professor, ECE Dept.,

Miss S. Jabeen, Assistant Professor, ECE Dept.,

V. S. S. Murty

Principal

PRINCIPAL
K.S.R.M. COLLEGE OF ENGINEE
KADAPA - 516 003. (A.P.)

Cc to:

The Management /Director / All Deans / All HODS/Staff / Students for information

The IQAC Cell for Documentation.

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Department of Electronics and Communication Engineering

Certificate Course on MATLAB FOR BEGINNERS

Registered Student List

S.No.	Roll Number	Name of the Student	Year & Branch	Eail id
1	189Y1A0402	ALLURI YADITHYA	B.Tech V sem, ECE	189Y1A0402@ksrmce.ac.in
2	189Y1A0403	ANDLURU PREM REDDY	B.Tech V sem, ECE	189Y1A0403@ksrmce.ac.in
3	189Y1A0404	ARAVA SHYAMDEEP	B.Tech V sem, ECE	189Y1A0404@ksrmce.ac.in
4	189Y1A0406	AVULA ADARSH KUMAR REDDY	B.Tech V sem, ECE	189Y1A0406@ksrmce.ac.in
5	189Y1A0407	AVULA NAGENDRABABU	B.Tech V sem, ECE	189Y1A0407@ksrmce.ac.in
6	189Y1A0408	AVULA SRIKANTH	B.Tech V sem, ECE	189Y1A0408@ksrmce.ac.in
7	189Y1A0409	BAIMUTHAKA MAHESH	B.Tech V sem, ECE	189Y1A0409@ksrmce.ac.in
8	189Y1A0414	BAYANABOINA REDDI SUBBARAYUDU	B.Tech V sem, ECE	189Y1A0414@ksrmce.ac.in
9	189Y1A0415	BEECHU CHETAN REDDY	B.Tech V sem, ECE	189Y1A0415@ksrmce.ac.in
10	189Y1A0416	BOGATHI HEMANTH KUMAR REDDY	B.Tech V sem, ECE	189Y1A0416@ksrmce.ac.in
11	189Y1A0417	BOGGALA CHANDRA SEKHAR	B.Tech V sem, ECE	189Y1A0417@ksrmce.ac.in
12	189Y1A0418	BOMMIREDDY LAKSHMI PRASANNA (W)	B.Tech V sem, ECE	189Y1A0418@ksrmce.ac.in
13	189Y1A0422	BOREDDY MANJUNATH REDDY	B.Tech V sem, ECE	189Y1A0422@ksrmce.ac.in
14	189Y1A0423	BUDDA SREEKANTH REDDY	B.Tech V sem, ECE	189Y1A0423@ksrmce.ac.in
15	189Y1A0424	BUGULU VINAY KUMAR	B.Tech V sem,	189Y1A0424@ksrmce.ac.

		REDDY	ECE	in
16	189Y1A0425	CHALLA LOKESHNAIDU	B.Tech V sem, ECE	189Y1A0425@ksrmce.ac.in
17	189Y1A0426	CHALLA SAI KISHORE	B.Tech V sem, ECE	189Y1A0426@ksrmce.ac.in
18	189Y1A0427	CHALLA SURENDRA REDDY	B.Tech V sem, ECE	189Y1A0427@ksrmce.ac.in
19	189Y1A0430	CHINTHALACHERUVU SAI NATH	B.Tech V sem, ECE	189Y1A0430@ksrmce.ac.in
20	189Y1A0431	DASARI SIVANI (W)	B.Tech V sem, ECE	189Y1A0431@ksrmce.ac.in
21	189Y1A0432	DEGALA PRAHARIKA (W)	B.Tech V sem, ECE	189Y1A0432@ksrmce.ac.in
22	189Y1A0435	EPPARLA MAHENDRA	B.Tech V sem, ECE	189Y1A0435@ksrmce.ac.in
23	189Y1A0436	G CHAITANYA	B.Tech V sem, ECE	189Y1A0436@ksrmce.ac.in
24	189Y1A0439	GANGANA PALLI SAI THANUJ	B.Tech V sem, ECE	189Y1A0439@ksrmce.ac.in
25	189Y1A0440	GANGIREDDY VAMSI KRISHNA REDDY	B.Tech V sem, ECE	189Y1A0440@ksrmce.ac.in
26	189Y1A0441	GANGIREDDYDEEPIKA (W)	B.Tech V sem, ECE	189Y1A0441@ksrmce.ac.in
27	189Y1A0443	GOLUKONDA RAHUL	B.Tech V sem, ECE	189Y1A0443@ksrmce.ac.in
28	189Y1A0444	GONTUMUKKALA JYOTHIRMAYEE SAI PRASANNA (W)	B.Tech V sem, ECE	189Y1A0444@ksrmce.ac.in
29	189Y1A0445	GOPISETTY NAVEEN KUMAR	B.Tech V sem, ECE	189Y1A0445@ksrmce.ac.in
30	189Y1A0447	GUDA GUNA SEKHAR REDDY	B.Tech V sem, ECE	189Y1A0447@ksrmce.ac.in
31	189Y1A0449	GUNDAMRAJU RAJESH	B.Tech V sem, ECE	189Y1A0449@ksrmce.ac.in
32	189Y1A0451	JONNALAGADLA HEMA LATHA (W)	B.Tech V sem, ECE	189Y1A0451@ksrmce.ac.in
33	189Y1A0453	KADAPANA VINAY KUMAR REDDY	B.Tech V sem, ECE	189Y1A0453@ksrmce.ac.in
34	189Y1A0454	KADIRI LAKSHMI SNEHA	B.Tech V sem, ECE	189Y1A0454@ksrmce.ac.in
35	189Y1A0455	KAKARLA MADHU MOHAN	B.Tech V sem,ECE	189Y1A0455@ksrmce.ac.in
36	189Y1A0456	KAMALAPURAM ARSHAD	B.Tech V sem, ECE	189Y1A0456@ksrmce.ac.in
37	189Y1A0458	KANAPARTHI DIVYA (W)	B.Tech V sem, ECE	189Y1A0458@ksrmce.ac.in

38	189Y1A0459	KARRU SREEKANTH REDDY	B.Tech V sem, ECE	189Y1A0459@ksrmce.ac.in
39	189Y1A0460	KASI REDDY SIRI VENNELA (W)	B.Tech V sem, ECE	189Y1A0460@ksrmce.ac.in
40	189Y1A0461	KATTAMEEDI MEGHANATH REDDY	B.Tech V sem, ECE	189Y1A0461@ksrmce.ac.in
41	189Y1A0462	KETHIREDDY ABHILASH KUMAR REDDY	B.Tech V sem, ECE	189Y1A0462@ksrmce.ac.in
42	189Y1A0463	KONDURU THARUN	B.Tech V sem, ECE	189Y1A0463@ksrmce.ac.in
43	189Y1A0464	KONGANI KIRAN	B.Tech V sem, ECE	189Y1A0464@ksrmce.ac.in
44	189Y1A0465	KOTHAKOTA CHINNARAYUDU	B.Tech V sem, ECE	189Y1A0465@ksrmce.ac.in
45	189Y1A0466	KOTTAGORLA REDDYVINOD	B.Tech V sem, ECE	189Y1A0466@ksrmce.ac.in
46	189Y1A0467	KOTTE MADHUBABU YADAV	B.Tech V sem, ECE	189Y1A0467@ksrmce.ac.in
47	189Y1A0468	KRISHNAM GANGA MAHESWAR REDDY	B.Tech V sem, ECE	189Y1A0468@ksrmce.ac.in
48	189Y1A0471	KURAKU NAGESWARA RAO	B.Tech V sem, ECE	189Y1A0471@ksrmce.ac.in
49	189Y1A0472	KURRA MANJULA (W)	B.Tech V sem, ECE	189Y1A0472@ksrmce.ac.in
50	189Y1A0473	LAKKIREDDY SAIPRANAVARSHITHA (W)	B.Tech V sem, ECE	189Y1A0473@ksrmce.ac.in
51	189Y1A0474	MADARASU SAI KRISHNA	B.Tech V sem, ECE	189Y1A0474@ksrmce.ac.in
52	189Y1A0475	MALEPATI DEEPALI (W)	B.Tech V sem, ECE	189Y1A0475@ksrmce.ac.in
53	189Y1A04A0	OMKARAM SRINIVASA DHEERAJ VARMA	B.Tech V sem, ECE	189Y1A04A0@ksrmce.ac.in
54	189Y1A04A1	PAGIDI RAMESH	B.Tech V sem, ECE	189Y1A04A1@ksrmce.ac.in
55	189Y1A04A2	PALAGIRI BHARGAVA REDDY	B.Tech V sem, ECE	189Y1A04A2@ksrmce.ac.in
56	189Y1A04F1	VAYALPATI RAMANJANEYULU	B.Tech V sem, ECE	189Y1A04F1@ksrmce.ac.in
57	189Y1A04F2	VELLABOYINA CHANDAN SAI VAMSI KRISHNA	B.Tech V sem, ECE	189Y1A04F2@ksrmce.ac.in
58	189Y1A04F3	VELLALA NAGA RUCHITHA (W)	B.Tech V sem, ECE	189Y1A04F3@ksrmce.ac.in
59	189Y1A04F4	VEMA VISHNUVARDHAN	B.Tech V sem, ECE	189Y1A04F4@ksrmce.ac.in
60	189Y1A04F5	VEMPALLI RAM NARAYAN SASANK	B.Tech V sem, ECE	189Y1A04F5@ksrmce.ac.in

61	199Y5AO401	ALAMURU VENKATA LAKSHMI (W)	B.Tech V sem, ECE	199Y5A0401@ksrmce.ac.in
62	199Y5A0404	BANDARU VIJAYKUMAR	B.Tech V sem, ECE	199Y5A0404@ksrmce.ac.in
63	199Y5A0406	DEPATLA VINAY KUMAR	B.Tech V sem, ECE	199Y5A0406@ksrmce.ac.in
64	199Y5A0411	KAMMA MAHENDRA KUMAR	B.Tech V sem, ECE	199Y5A0411@ksrmce.ac.in
65	199Y5A0420	KONDURU THARUN	B.Tech V sem, ECE	199Y5A0420@ksrmce.ac.in

Coordinator **HOD** **Principal**

Professor & H.O.D.
Department of E.C.E.
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MATLAB FOR BEGINNERS

30hrs

Course Objectives:

- Learn matlab programming.
- Understand the power of matlab.
- Gain knowledge to verify working of various tools.

Course Outcomes:

The students will be able to:

- Learn the matlab programming
- apply inbuilt functions available in matlab software
- Analyze and visualize any real time data for interpretation.

Module 1 : Brief Introduction,Installation of MATLAB, History, Use of MATLAB, Key features, Introduction to MATLAB Software-MATLAB window, command window, workspace, command history, setting directory, working with the MATLAB user interface, basic commands, assigning variables, operations with variables.

Module 2 : Data files and Data types - character and string, arrays and vectors, column vectors and row vectors, Basic Mathematics-arithmetic operations, operators and special operators, mathematical and logical operators, solving arithmetic equations. Operations on Matrix-creating rows and columns, matrix operations, finding transpose, determinant and inverse operations and solving matrices.

Module 3 : M files-working with script tools, writing script file, executing script files, the MATLAB Editor, saving m files,Plots-plotting vector and matrix data, plot labelling, curve labelling and editing, 2D plots-basic plotting functions, creating a plot, plotting multiple data sets in one graph, specifying line styles and colors, graphing imaginary and complex data. figure windows, displaying multiple plots in one figure, controlling the axes.

Module 4 : MATLAB Programming- automating commands with scripts, writing programs with logic and flow control, writing functions, control statements programming, conditional statement programming examples.

Module 5 : symbolic math in MATLAB- types of functions, global variables, calculus: Numerical integration, linear algebra, roots of polynomial equations, algebraic equations, differential equations, transforms (Fourier, Laplace, etc), ordinary differential equations, examples of few ODE's

Text book:

1. MATLAB: A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier, 2013

Resource:

1. Cody: A program developed by MathWorks that allows students to progressively develop MATLAB® programming skills and earn badges in the process.

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Department of Electronics & Communication Engineering

Certificate Course on MATLAB FOR BEGINNERS

Schedule

S.No	Date	Time	Faculty	Topic
1	09/11/2020	3 PM to 5PM	Dr. S.Zahiruddin Smt. S. SharmilaBanu Miss.S.Jabeen	Inauguration
2	10/11/2020	3PM to 5PM	Sri. S.SharmilaBanu Miss.S.Jabeen	Brief Introduction, Installation of MATLAB, History, Use of MATLAB, Key features, Introduction to MATLAB Software.
3	12/11/2020	3PM to 5PM	Dr.S.Zahiruddin	MATLAB window, command window, workspace, command history, setting directory, working with the MATLAB user interface.
4	13/11/2020	3PM to 5PM	Dr.S.Zahiruddin	Basic commands, assigning variables, operations with variables.
5	14/11/2020	3PM to 5PM	Dr.S.Zahiruddin	Data files and Data types - character and string, arrays and vectors, column vectors and row vectors.
6	15/11/2020	3PM to 5PM	Smt.S.SharmilaBanu	Basic Mathematics-arithmetic operations, operators and special operators, mathematical and logical operators.
7	16/11/2020	3PM to 6PM	Smt. S.SharmilaBanu	Solving arithmetic equations. Operations on Matrix-creating rows and columns, matrix operations, finding transpose.
8	17/11/2020	3PM to 6PM	Smt.S.SharmilaBanu	Determinant and inverse operations and solving matrices.

9	18/11/2020	3PM to 6PM	Smt.S.SharmilaBanu	M files-working with script tools, writing script file, executing script files, the MATLAB Editor, saving m files,Plots-plotting vector and matrix data, plot labeling.
10	19/11/2020	3PM to 6PM	Smt. S.SharmilaBanu	Plotting multiple data sets in one graph, specifying line styles and colors, graphing imaginary and complex data.
11	20/11/2020	3PM to 6PM	Smt. S.SharmilaBanu	MATLAB Programming-automating commands with scripts, writing programs with logic and flow control.
12	21/11/2020	3PM to 6PM	Dr.S.Zahiruddin Smt. S.SharimilaBanu Miss.S.Jabeen	Writing functions, control statements programming, conditional statement programming examples. **Exam and certificate distribution**

Coordinators **HOD** **Principal**

Professor & H.O.D.
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ACTIVITY REPORT

Certification Course

On

"MATLAB FOR BEGINNERS"

09th NOV, 2020 to 21st NOV, 2020

Target Group	:	Students
Details of Participants	:	65 Students
Co-ordinators	:	Smt. S. Sharmila Banu, Asst. Prof, Dept. of ECE
		Miss S. Jabeen, Asst. Prof, Dept. of ECE
Organizing Department	:	Department of Electronics and Communication Engineering
Venue	:	Online mode (Google meet)

Description: Certification course on "MATLAB for Beginners" was organized by Dept. of ECE from 09th NOV 2020 to 21st NOV 2020 in online mode. Dr. S. Zahiruddin, Smt. Sharmila Banu and Miss S. Jabeen acted as Course instructors. In industry, MATLAB is the tool of choice for high- productivity research, development, and analysis. MATLAB features a family of application-specific solutions called toolboxes. Basics and Toolboxes like signal processing, control systems are introduced.

Photo :

Smt. S. Sharmila Banu,

Miss S. Jabeen.

Coordinators

V.S.S. Murty

Principal

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Certificate Course on

MATLAB FOR BEGINNERS

09/11/2020 to 21/11/2020

Organized by

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

K.S.R.M. COLLEGE OF ENGINEERING

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Department of Electronics & Communication Engineering

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Attendance Sheet

S.No	Roll Num	Name of the Student	09/11/2020	10/11/2020	11/11/2020	12/11/2020	13/11/2020	14/11/2020	15/11/2020	16/11/2020	17/11/2020	18/11/2020	19/11/2020	20/11/2020	21/11/2020
1	189Y1A0402	ALLURI YADITHYA	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
2	189Y1A0403	ANDLURU PREM REDDY	✗	✓	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓	✓
3	189Y1A0404	ARAVA SHYAMDEEP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	189Y1A0406	AVULA ADARSH KUMAR REDDY	✓	✗	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	189Y1A0407	AVULA NAGENDRABABU	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓
6	189Y1A0408	AVULA SRIKANTH	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✓
7	189Y1A0409	BAIMUTHAKA MAHESH	✗	✓	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓	✗
8	189Y1A0414	BAYANABOINA REDDI SUBBARAYUDU	✓	✓	✗	✓	✗	✓	✗	✓	✗	✓	✓	✗	✓
9	189Y1A0415	BEECHU CHETAN REDDY	✓	✗	✓	✗	✓	✓	✓	✓	✗	✓	✗	✓	✓
10	189Y1A0416	BOGATHI HEMANTH KUMAR REDDY	✗	✗	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓	✓
11	189Y1A0417	BOGGALA CHANDRA SEKHAR	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓

12	189Y1A0418	BOMMIREDDY LAKSHMI PRASANNA (W)														
13	189Y1A0422	BOREDDY MANJUNATH REDDY														
14	189Y1A0423	BUDDA SREEKANTH REDDY														
15	189Y1A0424	BUGULU VINAY KUMAR REDDY														
16	189Y1A0425	CHALLA LOKESHNAIDU														
17	189Y1A0426	CHALLA SAI KISHORE														
18	189Y1A0427	CHALLA SURENDRA REDDY														
19	189Y1A0430	CHINTHALACHERUVU SAI NATH														
20	189Y1A0431	DASARI SIVANI (W)														
21	189Y1A0432	DEGALA PRAHARIKA (W)														
22	189Y1A0435	EPPARLA MAHENDRA														
23	189Y1A0436	G CHAITANYA														
24	189Y1A0439	GANGANA PALLI SAI THANUJ														
25	189Y1A0440	GANGIREDDY VAMSI KRISHNA REDDY														
26	189Y1A0441	GANGIREDDYDEEPIKA (W)														
27	189Y1A0443	GOLUKONDA RAHUL														
28	189Y1A0444	GONTUMUKKALA JYOTHIRMAYEE SAI PRASANNA (W)														
29	189Y1A0445	GOPISETTY NAVEEN KUMAR														
30	189Y1A0447	GUDA GUNA SEKHAR REDDY														
31	189Y1A0449	GUNDAMRAJU RAJESH														
32	189Y1A0451	JONNALAGADLA HEMA LATHA (W)														
33	189Y1A0453	KADAPANA VINAY KUMAR REDDY														
34	189Y1A0454	KADIRI LAKSHMI SNEHA														
35	189Y1A0455	KAKARLA MADHU MOHAN														
36	189Y1A0456	KAMALAPURAM ARSHAD														
37	189Y1A0458	KANAPARTHI DIVYA (W)														

38	189Y1A0459	KARRU SREEKANTH REDDY	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
39	189Y1A0460	KASI REDDY SIRI VENNELA (W)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40	189Y1A0461	KATTAMEEDI MEGHANATH REDDY	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓
41	189Y1A0462	KETHIREDDY ABHILASH KUMAR REDDY	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
42	189Y1A0463	KONDURU THARUN	✓	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓
43	189Y1A0464	KONGANI KIRAN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
44	189Y1A0465	KOTHAKOTA CHINNARAYUDU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗
45	189Y1A0466	KOTTAGORLA REDDYVINOD	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
46	189Y1A0467	KOTTE MADHUBABU YADAV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
47	189Y1A0468	KRISHNAM GANGA MAHESWAR REDDY	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓
48	189Y1A0471	KURAKU NAGESWARA RAO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
49	189Y1A0472	KURRA MANJULA (W)	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
50	189Y1A0473	LAKKIREDDY SAIPRANAVARSHITHA (W)	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✗
51	189Y1A0474	MADARASU SAI KRISHNA	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
52	189Y1A0475	MALEPATI DEEPALI (W)	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
53	189Y1A04A0	OMKARAM SRINIVASA DHEERAJ VARMA	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
54	189Y1A04A1	PAGIDI RAMESH	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
55	189Y1A04A2	PALAGIRI BHARGAVA REDDY	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
56	189Y1A04F1	VAYALPATI RAMANJANEYULU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
57	189Y1A04F2	VELLABOYINA CHANDAN SAI VAMSI KRISHNA	✓	✓	✓	✗	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓
58	189Y1A04F3	VELLALA NAGA RUCHITHA (W)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
59	189Y1A04F4	VEMA VISHNUVARDHAN	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
60	189Y1A04F5	VEMPALLI RAM NARAYAN SASANK	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
61	199Y5AO401	ALAMURU VENKATA LAKSHMI (W)	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✗	✓	✓

62	199Y5A0404	BANDARU VIJAYKUMAR	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
63	199Y5A0406	DEPATLA VINAY KUMAR	✓	✓	✗	✓	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓
64	199Y5A0411	KAMMA MAHENDRA KUMAR	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
65	199Y5A0420	KONDURU THARUN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓

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Flow control (loops)

- A for loop in MATLAB

```
for ind = 1:100
    b(ind)=sin(ind/10)
end
```

- Alternative (Most of the loops can be avoided!!!):

```
x=0.1:0.1:10;
b=sin(x);
```

- A while loop in

```
while x <= 10
    % execute these commands
end
```

Flow control (condition)

- An if - elseif - else structure. (Note that elseif is <u>one</u> word)

```
if expression1
   statements1
elseif expression2
   statements2
else
   statements3
end
```

- An switch-case structure

```
switch switch_expr
 case case_expr
   statement, ..., statement
 case {case_expr1, case_expr2, case_expr3, ...}
   statement, ..., statement
 otherwise
   statement, ..., statement
end
```

Saving Results

- We can save all our results for future reference.
- The command

  diary 'FileName'

  saves all output to command window into the FileName.txt file until this option is turned off by the command

  diary off
- The following commands save & load the entire workspace into the file 'MyMatFile.mat'
  - *save 'MyMatFile'*
  - *load 'MyMatFile'*
  - *save 'x.mat' x % save a specific variable*
- saving in ASCII format:
  - *x = (-1:0.4:1)' ; y = sin(x*pi)*
  - *var = [x y] % double-column*
  - *save 'my_sin.dat' -ASCII -double var* %Save in 16-digit ASCII format

M-Files

- An **M-file** might be used as a **script**, i.e. file consist set of statements
- In additional, one use M-files to write **function**, in this case the file starts with function definition like:

  function y = f(x)

  function [u,v] = f(x,y,z)
- **File name** and the **name of function** in the file are usually **identical**, however while they are different, MATLAB use file name to call function.
- If you add additional function in same M-file, it considered sub-function and might be called from inside the M-file only. Only the first function might be called from outside.

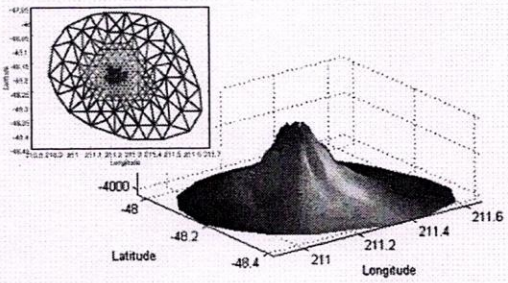
MATLAB also have humor

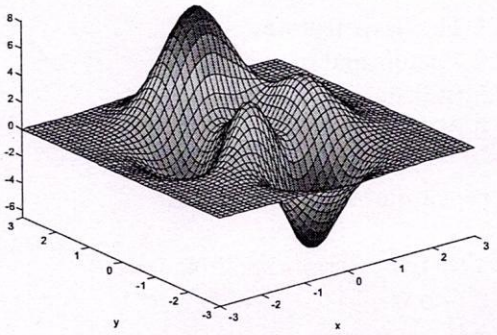
- why % try this command ☺

The End

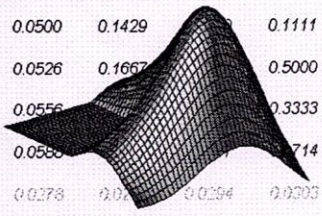
A Beginner's Guide to

MATLAB*





37	0.0135	0.0133	0.0132	0.0130	0.0128	0.0127
39	0.0233	0.0227	0.0222	0.0217	0.0213	0.0208
41	0.0238	0.0476	0.0455	0.0435	0.0417	0.0400
43	0.0244	0.0500	0.1429		0.1111	0.1000
45	0.0250	0.0526	0.1667		0.5000	0.0909
47	0.0256	0.0556			0.3333	0.0833
49	0.0263	0.0588			714	0.0769
52	0.0270	0.0278	0.0	0.0294	0.0303	0.0312
54	0.0156	0.0159	0.0161	0.0164	0.0167	0.0169
00	0.0101	0.0102	0.0103	0.0104	0.0105	0.0106



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* MATLAB is a registered trademark of The MathWorks Inc. A first draft of this document appeared as Technical Report 98-02, Department of Mathematics & Computer Science, Clarkson University.

TABLE OF CONTENTS

1. INTRODUCTION

MATLAB, which stands for **MAT**rix **LAB**oratory, is a state-of-the-art mathematical software package, which is used extensively in both academia and industry. It is an interactive program for *numerical* computation and data visualization, which along with its programming capabilities provides a very useful tool for almost all areas of science and engineering. Unlike other mathematical packages, such as MAPLE or MATHEMATICA, MATLAB cannot perform symbolic manipulations without the use of additional Toolboxes. It remains however, one of the leading software packages for *numerical* computation.

As you might guess from its name, MATLAB deals mainly with matrices. A scalar is a 1-by-1 matrix and a row vector of length say 5, is a 1-by-5 matrix. We will elaborate more on these and other features of MATLAB in the sections that follow. One of the many advantages of MATLAB is the natural notation used. It looks a lot like the notation that you encounter in a linear algebra course. This makes the use of the program especially easy and it is what makes MATLAB a natural choice for numerical computations.

The purpose of this tutorial is to familiarize the **beginner** to MATLAB, by introducing the basic features and commands of the program. It is in no way a complete reference and the reader is encouraged to further enhance his or her knowledge of MATLAB by reading some of the suggested references at the end of this guide.

1.1 MATLAB at Loyola College

MATLAB runs from ANY networked computer (e.g. your dorm room, the Math Lab in KH 318, etc). To access it, go to the MetaFrame Presentation Server, located at http://www.loyola.edu/moresoftware/ , and login using your Groupwise username and password - if your Groupwise password will not work then try you student ID number as a password. Once you login you will see a folder with applications, MATLAB being one of them. Double-click on the MATLAB icon and off you go ... Note: It is possible that the first time you do this, you may have to install some client software on your PC. Simply follow the instructions on the webpage (after you login) and you should be fine.

The program will start in a new window and once you see the prompt (») you will be ready to begin … The current (working) sub-directory is by default d:\Applications\matlabR14. You should not be saving any of your work in the default directory. Instead, you should switch to the G:\ drive that contains your account, by issuing the command

```
>> cd g:\
```

from within MATLAB. Talk to your professor for further instructions on how and where to save your work.

After you are done with MATLAB don't forget to logout of the MetaFrame Presentation Server.

1.2 How to read this tutorial

In the sections that follow, the MATLAB prompt (») will be used to indicate where the commands are entered. Anything you see after this prompt denotes user input (i.e. a command) followed by a carriage return (i.e. the "enter" key). Often, input is followed by output so unless otherwise specified the line(s) that follow a command will denote output (i.e. MATLAB's response to what you typed in). MATLAB is case-sensitive, which means that `a + B` is not the same as `a + b`. Different fonts, like the ones you just witnessed, will also be used to simulate the interactive session. This can be seen in the example below:

e.g. MATLAB can work as a calculator. If we ask MATLAB to add two numbers, we get the answer we expect.

```
» 3 + 4

ans =

     7
```

As we will see, MATLAB is much more than a "fancy" calculator. In order to get the most out this tutorial you are *strongly* encouraged to try *all* the commands introduced in each section and work on *all* the recommended exercises. This usually works best if after reading this guide once, you read it again (and possibly again and again) in front of a computer.

2. MATLAB BASICS

2.1 The basic features

Let us start with something simple, like defining a row vector with components the numbers 1, 2, 3, 4, 5 and assigning it a variable name, say x.

```
» x = [1 2 3 4 5]

x =
     1     2     3     4     5
```

Note that we used the equal sign for assigning the variable name x to the vector, brackets to enclose its entries and spaces to separate them. (Just like you would using the linear algebra notation). We could have used commas (,) instead of spaces to separate the entries, or even a combination of the two. The use of either spaces or commas is essential!

To create a column vector (MATLAB distinguishes between row and column vectors, as it should) we can either use semicolons (;) to separate the entries, or first define a row vector and take its *transpose* to obtain a column vector. Let us demonstrate this by defining a column vector y with entries 6, 7, 8, 9, 10 using both techniques.

```
» y = [6;7;8;9;10]

y =
     6
     7
     8
     9
    10

» y = [6,7,8,9,10]

y =
     6     7     8     9    10

» y'

ans =
     6
     7
     8
     9
    10
```

Let us make a few comments. First, note that to take the *transpose* of a vector (or a matrix for that matter) we use the single quote ('). Also note that MATLAB repeats (after it processes) what we typed in. Sometimes, however, we might not wish to "see" the output of a specific command. We can suppress the output by using a semicolon (;) at the end of the command line. Finally, keep in mind that MATLAB automatically assigns the variable name `ans` to anything that has not been assigned a name. In the example above, this means that a new variable has been created with the column vector entries as its value. The variable `ans`, however, gets recycled and every time we type in a command without assigning a variable, `ans` gets that value.

It is good practice to keep track of what variables are defined and occupy our workspace. Due to the fact that this can be cumbersome, MATLAB can do it for us. The command `whos` gives all sorts of information on what variables are active.

```
» whos
```

Name	Size	Elements	Bytes	Density	Complex
ans	5 by 1	5	40	Full	No
x	1 by 5	5	40	Full	No
y	1 by 5	5	40	Full	No

```
Grand total is 15 elements using 120 bytes
```

A similar command, called `who`, only provides the names of the variables that are active.

```
» who

Your variables are:

ans        x          y
```

If we no longer need a particular variable we can "erase" it from memory using the command `clear variable_name`. Let us `clear` the variable `ans` and check that we indeed did so.

```
» clear ans
» who

Your variables are:

x          y
```

The command `clear` used by itself, "erases" all the variables from the memory. Be careful, as this is not reversible and you do not have a second chance to change your mind.

You may exit the program using the `quit` command. When doing so, all variables are lost. However, invoking the command `save filename` before exiting, causes all variables to be written to a binary file called `filename.mat`. When we start MATLAB again, we may retrieve the information in this file with the command `load filename`. We can also create an ascii (text) file containing the entire MATLAB session if we use the command `diary filename` at the beginning and at the end of our session. This will create a text file called `filename` (with no extension) that can be edited with any text editor, printed out etc. This file will include *everything* we typed into MATLAB during the session (including error messages but excluding plots). We could also use the command `save filename` at the end of our session to create the binary file described above as well as the text file that includes our work.

One last command to mention before we start learning some more interesting things about MATLAB, is the `help` command. This provides help for any existing MATLAB command. Let us try this command on the command `who`.

```
» help who

 WHO List current variables.
     WHO lists the variables in the current workspace.
     WHOS lists more information about each variable.
     WHO GLOBAL and WHOS GLOBAL list the variables in the
     global workspace.
```

Try using the command `help` on itself!

On a PC, *help* is also available from the *Window Menus*. Sometimes it is easier to look up a command from the list provided there, instead of using the command line `help`.

2.2 Vectors and matrices

We have already seen how to define a vector and assign a variable name to it. Often it is useful to define vectors (and matrices) that contain equally spaced entries. This can be done by specifying the first entry, an increment, and the last entry. MATLAB will automatically figure out how many entries you need and their values. For example, to create a vector whose entries are 0, 1, 2, 3, …, 7, 8, you can type

```
» u = [0:8]

u =
     0     1     2     3     4     5     6     7     8
```

Here we specified the first entry 0 and the last entry 8, separated by a colon (:). MATLAB automatically filled-in the (omitted) entries using the (default) increment 1. You could also specify an increment as is done in the next example.

To obtain a vector whose entries are 0, 2, 4, 6, and 8, you can type in the following line:

```
» v = [0:2:8]

v =
     0     2     4     6     8
```

Here we specified the first entry 0, the increment value 2, and the last entry 8. The two colons (:) "tell" MATLAB to fill in the (omitted) entries using the specified increment value.

MATLAB will allow you to look at specific parts of the vector. If you want, for example, to only look at the first 3 entries in the vector *v*, you can use the same notation you used to create the vector:

```
» v(1:3)

ans =
     0     2     4
```

Note that we used parentheses, instead of brackets, to refer to the entries of the vector. Since we omitted the increment value, MATLAB automatically assumes that the increment is 1. The following command lists the first 4 entries of the vector *v*, using the increment value 2 :

```
» v(1:2:4)

ans =

     0     4
```

Defining a matrix is similar to defining a vector. To define a matrix A, you can treat it like a column of row vectors. That is, you enter each row of the matrix as a row vector (remember to separate the entries either by commas or spaces) and you separate the rows by semicolons (;).

```
» A = [1 2 3; 3 4 5; 6 7 8]

A =
     1     2     3
     3     4     5
     6     7     8
```

We can avoid separating each row with a semicolon if we use a carriage return instead. In other words, we could have defined A as follows

```
» A = [
1 2 3
3 4 5
6 7 8]

A =
     1     2     3
     3     4     5
     6     7     8
```

which is perhaps closer to the way we would have defined A by hand using the linear algebra notation.

You can refer to a particular entry in a matrix by using parentheses. For example, the number 5 lies in the 2nd row, 3rd column of A, thus

```
» A(2,3)

ans =
     5
```

The order of rows and columns follows the convention adopted in the linear algebra notation. This means that `A(2,3)` refers to the number 5 in the above example and `A(3,2)` refers to the number 7, which is in the 3rd row, 2nd column.

Note MATLAB's response when we ask for the entry in the 4th row, 1st column.

```
» A(4,1)
???  Index exceeds matrix dimensions.
```

As expected, we get an error message. Since A is a 3-by-3 matrix, there is no 4th row and MATLAB realizes that. The error messages that we get from MATLAB can be quite informative when trying to find out what went wrong. In this case MATLAB told us exactly what the problem was.

We can "extract" submatrices using a similar notation as above. For example to obtain the submatrix that consists of the first two rows and last two columns of A we type

```
» A(1:2,2:3)

ans =
     2     3
     4     5
```

We could even extract an entire row or column of a matrix, using the colon (:) as follows. Suppose we want to get the 2nd column of A. We basically want the elements `[A(1,2) A(2,2) A(3,2)]`. We type

```
» A(:,2)

ans =
     2
     4
     7
```

where the colon was used to tell MATLAB that all the rows are to be used. The same can be done when we want to extract an entire row, say the 3rd one.

```
» A(3,:)

ans =
     6     7     8
```

Define now another matrix B, and two vectors *s* and *t* that will be used in what follows.

```
» B = [
-1 3 10
-9 5 25
0 14 2]

B =
    -1     3    10
    -9     5    25
     0    14     2

» s = [-1 8 5]

s =
    -1     8     5

» t = [7;0;11]
```

```
t =
     7
     0
    11
```

The real power of MATLAB is the ease in which you can manipulate your vectors and matrices. For example, to subtract 1 from every entry in the matrix A we type

```
» A-1

ans =
     0     1     2
     2     3     4
     5     6     7
```

It is just as easy to add (or subtract) two compatible matrices (i.e. matrices of the same size).

```
» A+B

ans =
     0     5    13
    -6     9    30
     6    21    10
```

The same is true for vectors.

```
» s-t
??? Error using ==> -
Matrix dimensions must agree.
```

This error was expected, since *s* has size 1-by-3 and *t* has size 3-by-1. We will not get an error if we type

```
» s-t'

ans =
    -8     8    -6
```

since by taking the transpose of *t* we make the two vectors compatible.

We must be equally careful when using multiplication.

```
» B*s
??? Error using ==> *
Inner matrix dimensions must agree.

» B*t
```

```
ans =

   103
   212
    22
```

Another important operation that MATLAB can perform with ease is "matrix division". If M is an invertible[†] square matrix and b is a compatible vector then

`x = M\b` is the solution of $M\,x = b$ and
`x = b/M` is the solution of $x\,M = b$.

Let us illustrate the first of the two operations above with M = B and $b = t$.

```
» x=B\t

x =
    2.4307
    0.6801
    0.7390
```

x is the solution of $B\,x = t$ as can be seen in the multiplication below.

```
» B*x

ans =
    7.0000
    0.0000
   11.0000
```

Since x does not consist of integers, it is worth while mentioning here the command `format long`. MATLAB only displays four digits beyond the decimal point of a real number unless we use the command `format long`, which tells MATLAB to display more digits.

```
» format long

» x

x =
   2.43071593533487
   0.68013856812933
   0.73903002309469
```

On a PC the command `format long` can also be used through the Window Menus.

[†] Recall that a matrix $M \in \mathbb{R}^{n\times n}$ is called *invertible* if $Mx = 0 \;\Rightarrow\; x = 0 \quad \forall\, x \in \mathbb{R}^n$.

There are many times when we want to perform an operation to every entry in a vector or matrix. MATLAB will allow us to do this with "element-wise" operations.

For example, suppose you want to multiply each entry in the vector s with itself. In other words, suppose you want to obtain the vector $s^2 = [s(1)*s(1), s(2)*s(2), s(3)*s(3)]$.

The command `s*s` will not work due to incompatibility. What is needed here is to tell MATLAB to perform the multiplication element-wise. This is done with the symbols " `.*` ". In fact, you can put a period in front of most operators to tell MATLAB that you want the operation to take place on each entry of the vector (or matrix).

```
» s*s
??? Error using ==> *
Inner matrix dimensions must agree.

» s.*s

ans =
     1    64    25
```

The symbol " `.^` " can also be used since we are after all raising s to a power. (The period is needed here as well.)

```
» s.^2

ans =
     1    64    25
```

The table below summarizes the operators that are available in MATLAB.

+	addition
-	subtraction
*	multiplication
^	power
'	transpose
\	left division
/	right division

Remember that the multiplication, power and division operators can be used in conjunction with a period to specify an element-wise operation.

Exercises

Create a `diary` session called `sec2_2` in which you should complete the following exercises. Define

$$A = \begin{bmatrix} 2 & 9 & 0 & 0 \\ 0 & 4 & 1 & 4 \\ 7 & 5 & 5 & 1 \\ 7 & 8 & 7 & 4 \end{bmatrix}, \quad b = \begin{bmatrix} -1 \\ 6 \\ 0 \\ 9 \end{bmatrix}, \quad a = \begin{bmatrix} 3 & -2 & 4 & -5 \end{bmatrix}$$

1. Calculate the following (when defined)

(a) $A \cdot b$ **(b)** $a + 4$ **(c)** $b \cdot a$ **(d)** $a \cdot b^{\mathrm{T}}$ **(e)** $A \cdot a^{\mathrm{T}}$

2. Explain any differences between the answers that MATLAB gives when you type in `A*A`, `A^2` and `A.^2`.

3. What is the command that isolates the submatrix that consists of the 2nd to 3rd rows of the matrix A?

4. Solve the linear system $A\,x = b$ for x. Check your answer by multiplication.

Edit your text file to delete any errors (or typos) and hand in a readable printout.

2.3 Built-in functions

There are numerous built-in functions (i.e. commands) in MATLAB. We will mention a few of them in this section by separating them into categories.

Scalar Functions

Certain MATLAB functions are essentially used on scalars, but operate element-wise when applied to a matrix (or vector). They are summarized in the table below.

`sin`	trigonometric sine
`cos`	trigonometric cosine
`tan`	trigonometric tangent
`asin`	trigonometric inverse sine (arcsine)
`acos`	trigonometric inverse cosine (arccosine)
`atan`	trigonometric inverse tangent (arctangent)
`exp`	exponential
`log`	natural logarithm
`abs`	absolute value
`sqrt`	square root
`rem`	remainder
`round`	round towards nearest integer
`floor`	round towards negative infinity
`ceil`	round towards positive infinity

Even though we will illustrate some of the above commands in what follows, it is strongly recommended to get `help` on all of them to find out exactly how they are used.

The trigonometric functions take as input radians. Since MATLAB uses `pi` for the number $\pi = 3.1415\ldots$

```
» sin(pi/2)

ans =
     1

» cos(pi/2)

ans =
    6.1230e-017
```

The sine of $\pi/2$ is indeed 1 but we expected the cosine of $\pi/2$ to be 0. Well, remember that MATLAB is a *numerical* package and the answer we got (in scientific notation) is very close to 0 (`6.1230e-017` $= 6.1230\times10^{-17} \approx 0$).

Since the `exp` and `log` commands are straight forward to use, let us illustrate some of the other commands. The `rem` command gives the remainder of a division. So the remainder of 12 divided by 4 is zero

```
» rem(12,4)

ans =
     0
```

and the remainder of 12 divided by 5 is 2.

```
» rem(12,5)

ans =
     2
```

The `floor`, `ceil` and `round` commands are illustrated below.

```
» floor(1.4)

ans =
    1

» ceil(1.4)

ans =
    2
```

```
» round(1.4)

ans =

     1
```

Keep in mind that all of the above commands can be used on vectors with the operation taking place element-wise. For example, if $x = [0, 0.1, 0.2, \ldots, 0.9, 1]$, then $y = \exp(x)$ will produce another vector y, of the same length as x, whose entries are given by $y = [e^0, e^{0.1}, e^{0.2}, \ldots, e^1]$.

```
» x = [0:0.1:1]

x =

Columns 1 through 7

0    0.1000    0.2000    0.3000    0.4000    0.5000    0.6000

Columns 8 through 11

0.7000    0.8000    0.9000    1.0000

» y = exp(x)

y =

Columns 1 through 7

1.0000  1.1052  1.2214  1.3499  1.4918  1.6487  1.8221

Columns 8 through 11

2.0138  2.2255  2.4596  2.7183
```

This is extremely useful when plotting data. See *Section 2.4* ahead for more details on plotting.

Also, note that MATLAB displayed the results as 1-by-11 matrices (i.e. row vectors of length 11). Since there was not enough space on one line for the vectors to be displayed, MATLAB reports the column numbers.

Vector Functions

Other MATLAB functions operate essentially on vectors returning a scalar value. Some of these functions are given in the table below.

`max`	largest component
`min`	smallest component
`length`	length of a vector

`sort`	sort in ascending order
`sum`	sum of elements
`prod`	product of elements
`median`	median value
`mean`	mean value
`std`	standard deviation

Once again, it is strongly suggested to get `help` on all the above commands. Some are illustrated below.

Let z be the following row vector.

```
» z = [0.9347,0.3835,0.5194,0.8310]

z =
    0.9347    0.3835    0.5194    0.8310
```

Then

```
» max(z)

ans =
    0.9347

» min(z)

ans =
    0.3835

» sort(z)

ans =
    0.3835    0.5194    0.8310    0.9347

» sum(z)

ans =
    2.6686

» mean(z)

ans =
    0.6671
```

The above (vector) commands can also be applied to a matrix. In this case, they act in a column-by-column fashion to produce a row vector containing the results of their application to each column. The example below illustrates the use of the above (vector) commands on matrices.

Suppose we wanted to find the maximum element in the following matrix.

```
» M = [
0.7012,0.2625,0.3282
0.9103,0.0475,0.6326
0.7622,0.7361,0.7564];
```

If we used the `max` command on M, we will get the row in which the maximum element lies (remember the vector functions act on matrices in a column-by-column fashion).

```
» max(M)

ans =
    0.9103    0.7361    0.7564
```

To isolate the largest element, we must use the `max` command on the above row vector. Taking advantage of the fact that MATLAB assigns the variable name `ans` to the answer we obtained, we can simply type

```
» max(ans)

ans =
    0.9103
```

The two steps above can be combined into one in the following.

```
» max(max(M))

ans =
    0.9103
```

Combining MATLAB commands can be very useful when programming complex algorithms where we do not wish to see or access intermediate results. More on this, and other programming features of MATLAB in *Section 3* ahead.

Matrix Functions

Much of MATLAB's power comes from its matrix functions. These can be further separated into two sub-categories. The first one consists of convenient *matrix building functions*, some of which are given in the table below.

`eye`	identity matrix
`zeros`	matrix of zeros
`ones`	matrix of ones
`diag`	extract diagonal of a matrix or create diagonal matrices
`triu`	upper triangular part of a matrix
`tril`	lower triangular part of a matrix
`rand`	randomly generated matrix

Make sure you ask for `help` on all the above commands.

To create the identity matrix of size 4 (i.e. a square 4-by-4 matrix with ones on the main diagonal and zeros everywhere else) we use the command `eye`.

```
» eye(4,4)

ans =
     1     0     0     0
     0     1     0     0
     0     0     1     0
     0     0     0     1
```

The numbers in parenthesis indicates the size of the matrix. When creating *square* matrices, we can specify only one input referring to size of the matrix. For example, we could have obtained the above identity matrix by simply typing `eye(4)`. The same is true for the matrix building functions below.

Similarly, the command `zeros` creates a matrix of zeros and the command `ones` creates a matrix of ones.

```
» zeros(2,3)

ans =
     0     0     0
     0     0     0

» ones(2)

ans =
     1     1
     1     1
```

We can create a randomly generated matrix using the `rand` command. (The entries will be uniformly distributed between 0 and 1.)

```
» C = rand(5,4)

C =
    0.2190    0.3835    0.5297    0.4175
    0.0470    0.5194    0.6711    0.6868
    0.6789    0.8310    0.0077    0.5890
    0.6793    0.0346    0.3834    0.9304
    0.9347    0.0535    0.0668    0.8462
```

The commands `triu` and `tril`, extract the upper and lower part of a matrix, respectively. Let us try them on the matrix C defined above.

```
» triu(C)

ans =

    0.2190    0.3835    0.5297    0.4175
         0    0.5194    0.6711    0.6868
         0         0    0.0077    0.5890
         0         0         0    0.9304
         0         0         0         0

» tril(C)

ans =
    0.2190         0         0         0
    0.0470    0.5194         0         0
    0.6789    0.8310    0.0077         0
    0.6793    0.0346    0.3834    0.9304
    0.9347    0.0535    0.0668    0.8462
```

Once the extraction took place, the "empty" positions in the new matrices are automatically filled with zeros.

As mentioned earlier, the command `diag` has two uses. The first use is to extract a diagonal of a matrix, e.g. the main diagonal. Suppose D is the matrix given below. Then, `diag(D)` produces a column vector, whose components are the elements of D that lie on its main diagonal.

```
» D = [
0.9092 0.5045 0.9866
0.0606 0.5163 0.4940
0.9047,0.3190,0.2661];

» diag(D)

ans =
    0.9092
    0.5163
    0.2661
```

The second use is to create diagonal matrices. For example,

```
» diag([0.9092;0.5163;0.2661])

ans =
    0.9092         0         0
         0    0.5163         0
         0         0    0.2661
```

creates a diagonal matrix whose non-zero entries are specified by the vector given as input. (A short cut to the above construction is `diag(diag(D))`).
This command is not restricted to the main diagonal of a matrix; it works on off diagonals as well. See `help diag` for more information.

Let us now summarize some of the commands in the second sub-category of matrix functions.

`size`	size of a matrix
`det`	determinant of a square matrix
`inv`	inverse of a matrix
`rank`	rank of a matrix
`rref`	reduced row echelon form
`eig`	eigenvalues and eigenvectors
`poly`	characteristic polynomial
`norm`	norm of matrix (1-norm, 2-norm, ∞ -norm)
`cond`	condition number in the 2-norm
`lu`	LU factorization
`qr`	QR factorization
`chol`	Cholesky decomposition
`svd`	singular value decomposition

Don't forget to get `help` on the above commands. To illustrate a few of them, define the following matrix.

```
» A = [9,7,0;0,8,6;7,1,-6]

A =
     9     7     0
     0     8     6
     7     1    -6

» size(A)

ans =
     3     3

» det(A)

ans =
  -192
```

Since the determinant is not zero, the matrix is invertible.

```
» inv(A)

ans =
    0.2812   -0.2187   -0.2187
   -0.2187    0.2812    0.2812
    0.2917   -0.2083   -0.3750
```

We can check our result by verifying that $AA^{-1} = I$ and $A^{-1}A = I$.

```
» A*inv(A)

ans =
    1.0000    0.0000    0.0000
    0.0000    1.0000    0.0000
    0.0000    0.0000    1.0000

» inv(A)*A

ans =
    1.0000    0.0000         0
    0.0000    1.0000         0
    0.0000         0    1.0000
```

Let us comment on why MATLAB uses both 0's and 0.0000's in the answer above. Recall that we are dealing with a *numerical* package that uses numerical algorithms to perform the operations we ask for. Hence, the use of floating point (vs. exact) arithmetic causes the "discrepancy" in the results. From a practical point of view, 0 and 0.0000 are the same.

The *eigenvalues* and *eigenvectors* of A (i.e. the numbers λ and vectors x that satisfy $Ax = \lambda x$) can be obtained through the `eig` command.

```
» eig(A)

ans =
   12.6462
    3.1594
   -4.8055
```

produces a column vector with the eigenvalues and

```
» [X,D]=eig(A)

X =
   -0.8351   -0.6821    0.2103
   -0.4350    0.5691   -0.4148
   -0.3368   -0.4592    0.8853

D =
   12.6462         0         0
         0    3.1594         0
         0         0   -4.8055
```

produces a diagonal matrix D with the eigenvalues on the main diagonal, and a full matrix X whose columns are the corresponding eigenvectors.

Exercises

Create a `diary` session called `sec2_3` in which you should complete the following exercises using MATLAB commands. When applicable, use the matrix A and the vectors b, a that were defined in the previous section's exercises.

1. Construct a randomly generated 2-by-2 matrix of positive *integers*.

2. Find the *maximum* and *minimum* elements in the matrix A.

3. Sort the values of the vector b.

4. **(a)** Find the eigenvalues and eigenvectors of the matrix $B = A^{-1}$. Store the eigenvalues in a column vector you should name *lambda*.
(b) With I the 4-by-4 identity matrix, calculate the determinant of the matrix $B - lambda_j\, I$, for $j = 1, 2, 3, 4$. (Note: $lambda_1$ is the first eigenvalue, $lambda_2$ is the second eigenvalue etc.)

2.4 Plotting

We end our discussion on the basic features of MATLAB by introducing the commands for data visualization (i.e. plotting). By typing `help plot` you can see the various capabilities of this main command for two-dimensional plotting, some of which will be illustrated below.

If x and y are two vectors of the same length then `plot(x,y)` plots x versus y.

For example, to obtain the graph of $y = \cos(x)$ from $-\pi$ to π, we can first define the vector x with components equally spaced numbers between $-\pi$ and π, with increment, say 0.01.

```
» x=-pi:0.01:pi;
```

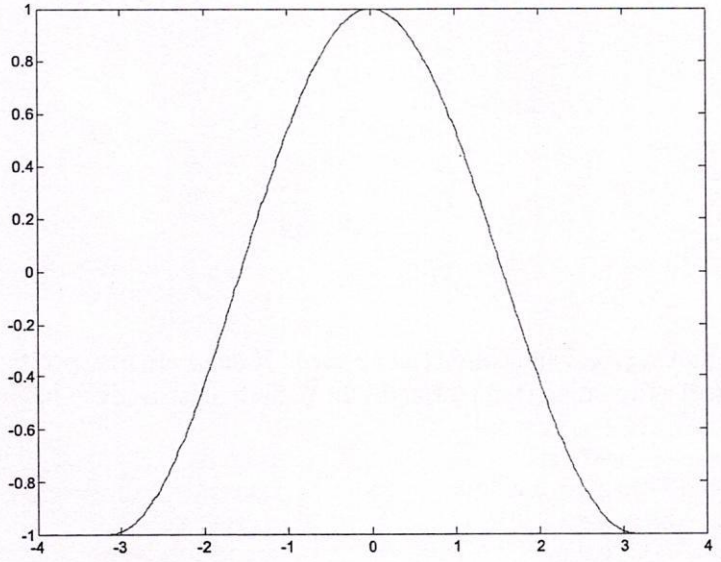
We placed a semicolon at the end of the input line to avoid seeing the (long) output.
Note that the smallest the increment, the "smoother" the curve will be.
1 – 2
Next, we define the vector y

```
» y=cos(x);
```

(using a semicolon again) and we ask for the plot

```
» plot(x,y)
```

At this point a new window will open on our desktop in which the graph (as seen below) will appear.



It is good practice to label the axis on a graph and if applicable indicate what each axis represents. This can be done with the `xlabel` and `ylabel` commands.

```
» xlabel('x')
» ylabel('y=cos(x)')
```

Inside parentheses, and enclosed within single quotes, we type the text that we wish to be displayed along the *x* and *y* axis, respectively.

We could even put a title on top using

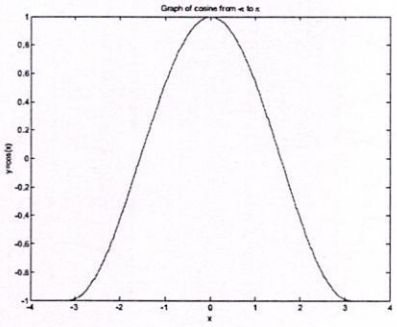
```
» title('Graph of cosine from - \pi to \pi')
```

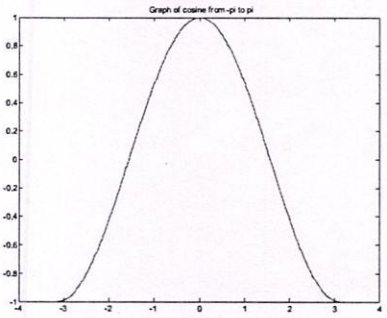
as long as we remember to enclose the text in parentheses within single quotes. The back-slash (\ ) in front of `pi` allows the user to take advantage of LaTeX commands. If you are not familiar with the mathematical typesetting software LaTeX (and its commands), ignore the present commend and simply type

```
» title('Graph of cosine from -pi to pi')
```

Both graphs are shown below.

These commands can be invoked even after the plot window has been opened and MATLAB will make all the necessary adjustments to the display.





Various line types, plot symbols and colors can be used. If these are not specified (as in the case above) MATLAB will assign (and cycle through) the default ones as given in the table below.

y	yellow	.	point
m	magenta	o	circle
c	cyan	x	x-mark
r	red	+	plus
g	green	-	solid
b	blue	*	star
w	white	:	dotted
k	black	-.	dashdot
		--	dashed

So, to obtain the same graph but in *green*, we type

```
» plot(x,y,'g')
```

where the third argument indicating the color, appears within single quotes. We could get a *dashed* line instead of a *solid* one by typing

```
» plot(x,y,'--')
```

or even a combination of line type and color, say a *blue dotted* line by typing

```
» plot(x,y,'b:')
```

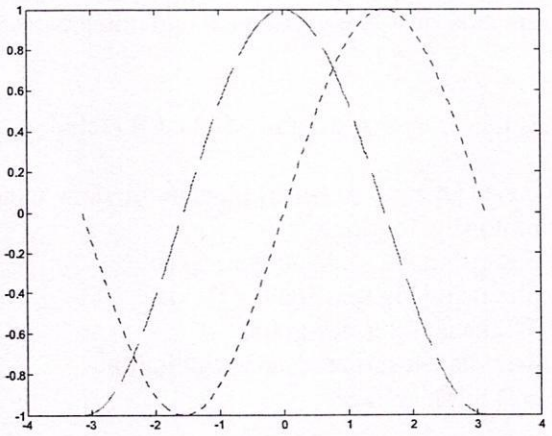
Multiple curves can appear on the same graph. If for example we define another vector

```
» z = sin(x);
```

we can get both graphs on the same axis, distinguished by their line type, using

```
» plot(x,y,'r--',x,z,'b:')
```

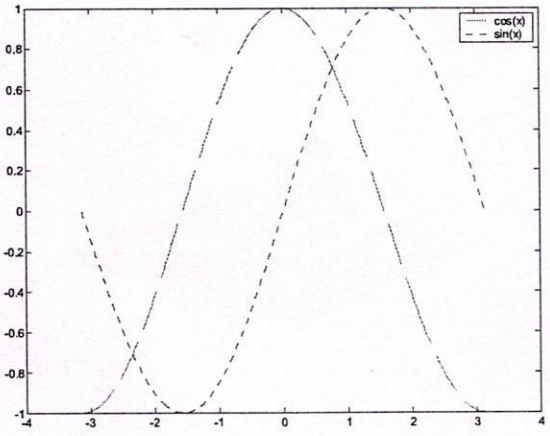
The resulting graph can be seen below, with the *red dashed* line representing $y = \cos(x)$ and the *blue dotted* line representing $z = \sin(x)$.



When multiple curves appear on the same axis, it is a good idea to create a *legend* to label and distinguish them. The command `legend` does exactly this.

```
» legend('cos(x)','sin(x)')
```

The text that appears within single quotes as input to this command, represents the legend labels. We must be consistent with the ordering of the two curves, so since in the `plot` command we asked for *cosine* to be plotted before *sine*, we must do the same here.



At any point during a MATLAB session, you can obtain a hard copy of the current plot by either issuing the command `print` at the MATLAB prompt, or by using the command menus on the plot window. In addition, MATLAB plots can by *copied* and *pasted* (as pictures) in your favorite word processor (such as Microsoft Word). This can be achieved using the Edit menu on the figure window.

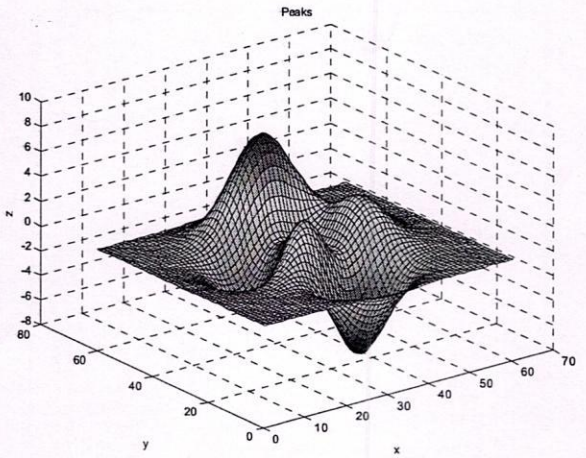
Another nice feature that can be used in conjunction with `plot` is the command `grid`, which places grid lines to the current axis (just like you have on graphing paper). Type `help grid` for more information.

Other commands for data visualization that exist in MATLAB include

`subplot`	create an array of (tiled) plots in the same window
`loglog`	plot using log-log scales
`semilogx`	plot using log scale on the *x*-axis
`semilogy`	plot using log scale on the *y*-axis
`surf`	3-D shaded surface graph
`surfl`	3-D shaded surface graph with lighting
`mesh`	3-D mesh surface

It is left to the reader to further investigate the above commands through MATLAB's `help` command. We illustrate here how to obtain one of the surface pictures on the cover of this guide:

```
>> [x,y] = meshgrid(-3:.1:3,-3:.1:3);
>> z = 3*(1-x).^2.*exp(-(x.^2) - (y+1).^2) ...
   - 10*(x/5 - x.^3 - y.^5).*exp(-x.^2-y.^2) ...
   - 1/3*exp(-(x+1).^2 - y.^2);
>> surf(z)
>> xlabel('x')
>> ylabel('y')
>> zlabel('z')
>> title('Peaks')
```



Type `help meshgrid`, `help surf` and `help peaks` for more information on the above surface.

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2	189Y1A0403@ksrmce.ac.in	ANDLURU PREM REDDY	B.Tech Vsem	ECE	189Y1A0403	Yes	Yes	Agree	Agree	Strongly agree	5	5	Nothing
3	189Y1A0404@ksrmce.ac.in	ARAVA SHYAMDEEP	B.Tech Vsem	ECE	189Y1A0404	Yes	Yes	Agree	Agree	Strongly agree	4	5	Good
4	189Y1A0406@ksrmce.ac.in	AVULA ADARSH KUMAR REDDY	B.Tech Vsem	ECE	189Y1A0406	Yes	Yes	Agree	Agree	Strongly agree	5	5	nothing
5	189Y1A0407@ksrmce.ac.in	AVULA NAGENDRABABU	B.Tech Vsem	ECE	189Y1A0407	Yes	Yes	Agree	Agree	Strongly agree	5	5	Good
6	189Y1A0408@ksrmce.ac.in	AVULA SRIKANTH	B.Tech Vsem	ECE	189Y1A0408	Yes	Yes	Agree	Agree	Strongly agree	4	5	very good
7	189Y1A0409@ksrmce.ac.in	BAIMUTHAKA MAHESH	B.Tech Vsem	ECE	189Y1A0409	Yes	Yes	Strongly agree	Agree	Strongly agree	4	3	Nothing
8	189Y1A0414@ksrmce.ac.in	BAYANABOINA REDDI SUBBARAYUDU	B.Tech Vsem	ECE	189Y1A0414	Yes	Yes	agree	Agree	Strongly agree	4	4	no

9	189Y1A0415@ksrmce.ac.in	BEECHU CHETAN REDDY	B.Tech Vsem	ECE	189Y1A0415	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	Nothing
10	189Y1A0416@ksrmce.ac.in	BOGATHI HEMANTH KUMAR REDDY	B.Tech Vsem	ECE	189Y1A0416	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	Good
11	189Y1A0417@ksrmce.ac.in	BOGGALA CHANDRA SEKHAR	B.Tech Vsem	ECE	189Y1A0417	Yes	Yes	Agree	Agree	Strongly agree	5	4	Good
12	189Y1A0418@ksrmce.ac.in	LAKSHMI PRASANNA (W)	B.Tech Vsem	ECE	189Y1A0418	Yes	Yes	agree	Agree	Strongly agree	5	5	Good
13	189Y1A0422@ksrmce.ac.in	BOREDDY MANJUNATH REDDY	B.Tech Vsem	ECE	189Y1A0422	Yes	Yes	agree	Agree	Strongly agree	3	5	Good
14	189Y1A0423@ksrmce.ac.in	BUDDA SREEKANTH REDDY	B.Tech Vsem	ECE	189Y1A0423	Yes	Yes	agree	Agree	Strongly agree	5	4	very good
15	189Y1A0424@ksrmce.ac.in	BUGULU VINAY KUMAR REDDY	B.Tech Vsem	ECE	189Y1A0424	Yes	Yes	agree	Agree	Strongly agree	4	4	very good
16	189Y1A0425@ksrmce.ac.in	CHALLA LOKESHNAIDU	B.Tech Vsem	ECE	189Y1A0425	Yes	Yes	agree	Agree	Strongly agree	5	4	very good
17	189Y1A0426@ksrmce.ac.in	CHALLA SAI KISHORE	B.Tech Vsem	ECE	189Y1A0426	Yes	Yes	agree	Agree	Strongly agree	3	5	no
18	189Y1A0427@ksrmce.ac.in	CHALLA SURENDRA REDDY	B.Tech Vsem	ECE	189Y1A0427	Yes	Yes	agree	Agree	Strongly agree	4	5	nithing
19	189Y1A0430@ksrmce.ac.in	CHINTHALACHERUVU SAI NATH	B.Tech Vsem	ECE	189Y1A0430	Yes	Yes	Strongly agree	Agree	Strongly agree	4	5	Good
20	189Y1A0431@ksrmce.ac.in	DASARI SIVANI (W)	B.Tech Vsem	ECE	189Y1A0431	Yes	Yes	Strongly agree	Agree	Strongly agree	4	4	Good
21	189Y1A0432@ksrmce.ac.in	DEGALA PRAHARIKA (W)	B.Tech Vsem	ECE	189Y1A0432	Yes	Yes	Strongly agree	Agree	Strongly agree	4	3	Good
22	189Y1A0435@ksrmce.ac.in	EPPARLA MAHENDRA	B.Tech Vsem	ECE	189Y1A0435	Yes	Yes	agree	Agree	Strongly agree	4	4	Good
23	189Y1A0436@ksrmce.ac.in	G CHAITANYA	B.Tech Vsem	ECE	189Y1A0436	Yes	Yes	agree	Agree	Strongly agree	5	4	Good
24	189Y1A0439@ksrmce.ac.in	GANGANA PALLI SAI THANUJ	B.Tech Vsem	ECE	189Y1A0439	Yes	Yes	Strongly agree	Agree	Strongly agree	5	4	Good
25	189Y1A0440@ksrmce.ac.in	GANGIREDDY VAMSI KRISHNA REDDY	B.Tech Vsem	ECE	189Y1A0440	Yes	Yes	agree	Agree	Strongly agree	5	5	Good

26	189Y1A0441@ksrmce.ac.in	GANGIREDDYDEEPIKA (W)	B.Tech Vsem	ECE	189Y1A0441	Yes	Yes	agree	Agree	Strongly agree	5	5	Nothing
27	189Y1A0443@ksrmce.ac.in	GOLUKONDA RAHUL	B.Tech Vsem	ECE	189Y1A0443	Yes	Yes	agree	Agree	Strongly agree	5	5	no
28	189Y1A0444@ksrmce.ac.in	GUNTUMUKKALA JYOTHIRMAYEE SAI PRASANNA (W)	B.Tech Vsem	ECE	189Y1A0444	Yes	Yes	agree	Agree	Strongly agree	3	4	no
29	189Y1A0445@ksrmce.ac.in	GOPISETTY NAVEEN KUMAR	B.Tech Vsem	ECE	189Y1A0445	Yes	Yes	Strongly agree	Agree	Strongly agree	3	4	no
30	189Y1A0447@ksrmce.ac.in	GUDA GUNA SEKHAR REDDY	B.Tech Vsem	ECE	189Y1A0447	Yes	Yes	Strongly agree	Agree	Strongly agree		5	no
31	189Y1A0449@ksrmce.ac.in	GUNDAMRAJU RAJESH	B.Tech Vsem	ECE	189Y1A0449	Yes	Yes	Strongly agree	Agree	Strongly agree	5	4	nothing
32	189Y1A0451@ksrmce.ac.in	JONNALAGADLA HEMA LATHA (W)	B.Tech Vsem	ECE	189Y1A0451	Yes	Yes	agree	Agree	Strongly agree	5	5	Nothing
33	189Y1A0453@ksrmce.ac.in	KADAPANA VINAY KUMAR REDDY	B.Tech Vsem	ECE	189Y1A0453	Yes	Yes	agree	Agree	Strongly agree	5	4	no
34	189Y1A0454@ksrmce.ac.in	KADIRI LAKSHMI SNEHA	B.Tech Vsem	ECE	189Y1A0454	Yes	Yes	agree	Agree	Strongly agree	5	4	Nothing
35	189Y1A0455@ksrmce.ac.in	KAKARLA MADHU MOHAN	B.Tech Vsem	ECE	189Y1A0455	Yes	Yes	agree	Agree	Strongly agree	5	4	Good
36	189Y1A0456@ksrmce.ac.in	KAMALAPURAM ARSHAD	B.Tech Vsem	ECE	189Y1A0456	Yes	Yes	agree	Agree	Strongly agree	5	5	Good
37	189Y1A0458@ksrmce.ac.in	KANAPARTHI DIVYA (W)	B.Tech Vsem	ECE	189Y1A0458	Yes	Yes	agree	Agree	Strongly agree	5	5	Good
38	189Y1A0459@ksrmce.ac.in	KARRU SREEKANTH REDDY	B.Tech Vsem	ECE	189Y1A0459	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	Good
39	189Y1A0460@ksrmce.ac.in	KASI REDDY SIRI VENNELA (W)	B.Tech Vsem	ECE	189Y1A0460	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	Good
40	189Y1A0461@ksrmce.ac.in	KATTAMEEDI MEGHANATH REDDY	B.Tech Vsem	ECE	189Y1A0461	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	Good
41	189Y1A0462@ksrmce.ac.in	ABHILASH KUMAR REDDY	B.Tech Vsem	ECE	189Y1A0462	Yes	Yes	agree	Agree	Strongly agree	4	4	Good

42	189Y1A0463@ksrmce.ac.in	KONDURU THARUN	B.Tech Vsem	ECE	189Y1A0463	Yes	Yes	agree	Agree	Strongly agree	4	5	Good
43	189Y1A0464@ksrmce.ac.in	KONGANI KIRAN	B.Tech Vsem	ECE	189Y1A0464	Yes	Yes	agree	Agree	Strongly agree	4	5	Good
44	189Y1A0465@ksrmce.ac.in	KOTHAKOTA CHINNARAYUDU	B.Tech Vsem	ECE	189Y1A0465	Yes	Yes	agree	Agree	Strongly agree	3	5	Good
45	189Y1A0466@ksrmce.ac.in	KOTTAGORLA REDDYVINOD	B.Tech Vsem	ECE	189Y1A0466	Yes	Yes	agree	Agree	Strongly agree	3	5	Nothing
46	189Y1A0467@ksrmce.ac.in	KOTTE MADHUBABU YADAV	B.Tech Vsem	ECE	189Y1A0467	Yes	Yes	Strongly agree	Agree	Strongly agree	2	5	Nothing
47	189Y1A0468@ksrmce.ac.in	KRISHNAM GANGA MAHESWAR REDDY	B.Tech Vsem	ECE	189Y1A0468	Yes	Yes	agree	Agree	Strongly agree	2	5	very good
48	189Y1A0471@ksrmce.ac.in	KURAKU NAGESWARA RAO	B.Tech Vsem	ECE	189Y1A0471	Yes	Yes	agree	Agree	Strongly agree	4	5	very good
49	189Y1A0472@ksrmce.ac.in	KURRA MANJULA (W)	B.Tech Vsem	ECE	189Y1A0472	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	very good
50	189Y1A0473@ksrmce.ac.in	LAKKIREDDY SAIPRANAVARSHITHA	B.Tech Vsem	ECE	189Y1A0473	Yes	Yes	Strongly agree	Agree	Strongly agree	4	5	nothing
51	189Y1A0474@ksrmce.ac.in	MADARASU SAI KRISHNA	B.Tech Vsem	ECE	189Y1A0474	Yes	Yes	agree	Agree	Strongly agree	4	5	Good
52	189Y1A0475@ksrmce.ac.in	MALEPATI DEEPALI (W)	B.Tech Vsem	ECE	189Y1A0475	Yes	Yes	agree	Agree	Strongly agree	4	5	Good
53	189Y1A04A0@ksrmce.ac.in	SRINIVASA DHEERAJ VARMA	B.Tech Vsem	ECE	189Y1A04A0	Yes	Yes	agree	Agree	Strongly agree	4	5	nothing
54	189Y1A04A1@ksrmce.ac.in	PAGIDI RAMESH	B.Tech Vsem	ECE	189Y1A04A1	Yes	Yes	agree	Agree	Strongly agree	4	5	nothing
55	189Y1A04A2@ksrmce.ac.in	PALAGIRI BHARGAVA REDDY	B.Tech Vsem	ECE	189Y1A04A2	Yes	Yes	agree	Agree	Strongly agree	4	5	nothing
56	189Y1A04F1@ksrmce.ac.in	VAYALPATI RAMANJANEYULU	B.Tech Vsem	ECE	189Y1A04F1	Yes	Yes	agree	Agree	Strongly agree	4	5	Good
57	189Y1A04F2@ksrmce.ac.in	CHANDAN SAI VAMSI KRISHNA	B.Tech Vsem	ECE	189Y1A04F2	Yes	Yes	agree	Agree	Strongly agree	5	5	Good
58	189Y1A04F3@ksrmce.ac.in	VELLALA NAGA RUCHITHA (W)	B.Tech Vsem	ECE	189Y1A04F3	Yes	Yes	agree	Agree	Strongly agree	5	5	very good

59	189Y1A04F4@ksrmce.ac.in	VEMA VISHNUVARDHAN	B.Tech Vsem	ECE	189Y1A04F4	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	very good
60	189Y1A04F5@ksrmce.ac.in	VEMPALLI RAM NARAYAN SASANK	B.Tech Vsem	ECE	189Y1A04F5	Yes	Yes	Strongly agree	Agree	Strongly agree	5	5	nothing
61	199Y5A0401@ksrmce.ac.in	ALAMURU VENKATA LAKSHMI (W)	B.Tech Vsem	ECE	199Y5AO401	Yes	Yes	agree	Agree	Strongly agree	5	5	no
62	199Y5A0404@ksrmce.ac.in	BANDARU VIJAYKUMAR	B.Tech Vsem		199Y5AO404	Yes	Yes	agree	Agree	Strongly agree	5	5	no
63	199Y5A0406@ksrmce.ac.in	DEPATLA VINAY KUMAR	B.Tech Vsem	ECE	199Y5A0406	Yes	Yes	agree	Agree	Strongly agree	5	5	no
64	199Y5A0411@ksrmce.ac.in	KAMMA MAHENDRA KUMAR	B.Tech Vsem	ECE	199Y5A0411	Yes	Yes	agree	Agree	Strongly agree	5	5	no
65	199Y5A0420@ksrmce.ac.in	KONDURU THARUN	B.Tech Vsem	ECE	199Y5A0420	Yes	Yes	agree	Agree	Strongly agree	5	5	no

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