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Faculty of Engineering & Technology

Department of Interdisciplinary studies

STEM Foundation

Semester 2 -In class Test 2

Module Code	:	STEM 1511
Module Title	:	Foundation Mathematics II
Date	:	9th June 2026
Examiners	:	Hiruni Wickramasinghe
Time Allowed	:	(09 00 am - 11.00 am)- 2 hrs.

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of **eight (08) questions**. Answer all eight questions.
- Use only the provided answer sheets for your answers.
- Write clearly and legibly using a blue or black pen.
- **You may use a scientific Calculator. This must not be programmable and may be inspected during the examination**
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.

1. Find the limits for the following expressions, if it exists.

   i. $\lim_{x \to 2}(6x^4 - 7x^3 + 12x + 25)$

   ii. $\lim_{x \to 7} \frac{x^2-4x-21}{x-7}$

   iii. $\lim_{t \to -5} \frac{t^2+6t+5}{t^2+2t-15}$

   iv. $\lim_{x \to 0} \frac{x}{3-\sqrt{x+9}}$

   v. $\lim_{x \to \infty} \frac{6+3x^2}{5x^2+7x}$ **(18 marks)**

2. Let $f(x) = 4x^3 + 3x^2 + 2x + 1$.Using the first principles, find $f'(x)$.
(10 marks)

3. Find the first Derivative of with respect to x.

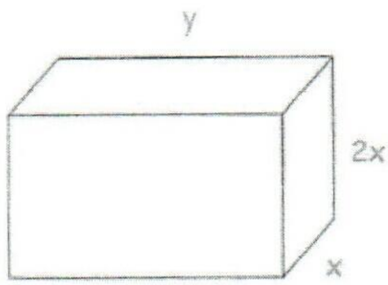
   i. $f(x) = 13x^5 + 5x^4 - 4x^3 + 12$
   ii. $f(x) = 2xe^x$
   iii. $f(x) = (x^2 + 4)(x + 3)$
   iv. $f(x) = \frac{sinx}{x^2}$
   v. $f(x) = cos^2x$ **(18 marks)**
   vi. $f(x) = \ln(x^4 + x)$

4. Find the slope (gradient) of the tangent line to the graph of $f(x) = 2x^2 + 3x$ at the point (1,5) **(8 marks)**

5. Let $f(t) = 2t^2 + 6t + 7$.Find the instantaneous rate of change of $f(t)$ when $t = -1$.
(8 marks)

6. Let $y = xe^{2x}$,show clearly that $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} - 4y = 0$ **(10 marks)**

7. Sketch the graph of the function $f(x) = x^3 - 2x^2 - 4x + 5$ indicating the local maximum/minimum points and the point of inflection. **(10 marks)**



8. Shown below is a cuboid

The surface area of the cuboid is 120cm^2

a) Show that $y = \frac{20}{x} - \frac{2x}{3}$
b) Show that the volume of the cuboid is given by $V = 120x - 4x^3$
c) Use differentiation to find the value of x for which V is a maximum.

(18 marks)

Function $y = y(x)$	$\frac{dy}{dx}$	Function $y = y(x)$	$\frac{dy}{dx}$
x^n	nx^{n-1}	e^x	e^x
$\sin x$	$\cos x$	$\ln x = \log_e x$	$\frac{1}{x}$
$\cos x$	$-\sin x$	$\sinh x$	$\cosh x$
$\tan x$	$\sec^2 x$	$\cosh x$	$\sinh x$
$\operatorname{cosec} x$	$-\operatorname{cosec} x \cot x$	$\tanh x$	$\operatorname{sech}^2 x$
$\sec x$	$\sec x \tan x$	$\operatorname{cosech} x$	$-\operatorname{cosech} x \coth x$
$\cot x$	$-\operatorname{cosec}^2 x$	$\operatorname{sech} x$	$-\operatorname{sech} x \tanh x$

Product Rule

$$\frac{d}{dx}(uv) = \frac{du}{dx}.v + u.\frac{dv}{dx}$$

Quotient Rule

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v.\frac{du}{dx} - u.\frac{dv}{dx}}{v^2}$$

Function of a Function Rule

If $y = y(u)$ and $u = u(x)$ then $\frac{dy}{dx} = \frac{dy}{du}.\frac{du}{dx}$

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CINEC CAMPUS
Beyond A Graduate

Faculty of Engineering & Technology Department of Interdisciplinary Studies BSc. Hons. (Eng.) in Automotive/Mechanical/Mechatronic/Electrical/Civil Engineering Semester 4 First Sit - Final Examination 2026 Batch 7	
Module Code: FE 2321	Module Title: Engineering Mathematics IV
Date: 26th May 2026	Duration: 3 hours
Examiner	Dr. Shelton Perera

Instructions to Candidates:

- *This is a closed book examination.*
- *This paper consists of four* (4) *questions and* 9 *pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*
- *Additional information is provided on pages* 5, 6, 7, 8 *and* 9.
- *You may use a Scientific Calculator. This must not be programmable and may be inspected during the examination.*

1.

i) Let $f(x,y) = x^4 + y^4 - 4xy + 1$.

a) Find $f_x(x,y)$, $f_y(x,y)$, $f_{xx}(x,y)$, $f_{yy}(x,y)$, and $f_{xy}(x,y)$. (10 Marks)

b) Find and classify the stationary points of f. (20 Marks)

ii) A manufacturer wants to build an open-top rectangular box with volume $32\ \text{m}^3$. Find the dimensions of the box that minimize the total surface area. (30 Marks)

iii) Let $f(x,y,z) = 2xy^2 + y\,z^2 + xz^3$. Find the magnitude of the greatest rate of change of f at $(1,1,1)$. (15 Marks)

iv) Consider the vector field $\boldsymbol{F} = (2x + yz)\boldsymbol{i} + (xz + 3y^2)\boldsymbol{j} + (xy + 5z)\boldsymbol{k}$.

a) Show that $\boldsymbol{F}$ is irrotational. (15 Marks)

b) Find the divergence of $\boldsymbol{F}$ in general terms and at the point (1, 1, 1). (10 Marks)

2.

i) Evaluate $\int_0^2 \int_0^x (x^2\, y + e^x)\, dydx$. (25 Marks)

ii) Let V be the tetrahedron bounded by the planes $x = 0, y = 0, z = 0$ and $x + y + z = 1$. Find the value of $\iiint_V\ x\, dV$. (35 Marks)

iii) Let R be the region bounded by the lines $x + y = 0, x + y = 2$, $x - y = 1$ and $x - y = 3$. Evaluate $\iint_R\ (x^2 - y^2)\, dA$. (40 Marks)

3.

i) Let $\boldsymbol{F} = (3x^2y + z^3)\boldsymbol{i} + (x^3 + 2yz)\boldsymbol{j} + (3xz^2 + y^2)\boldsymbol{k}$.

Also, let C be the curve from $O = (0,0,0)$ to $A = (1,1,1)$ consisting of

$C_1 : x = t,\ y = t^2,\ z = 0\ (0 \le t \le 1)$ and

$C_2 : x = 1,\ y = 1,\ z = t\ (0 \le t \le 1)$.

a) Find $\int_C \boldsymbol{F}.\boldsymbol{dr}$. (20 Marks)

b) Show that $\boldsymbol{F}$ is a conservative vector field. (15 Marks)

c) Find a scalar field φ such that $\boldsymbol{\nabla}\varphi=\boldsymbol{F}$. (15 Marks)

d) Find $\int_{C_3} \boldsymbol{F}.\boldsymbol{dr}$, where C_3 is any path from (1,0,0) to (0,1,1). (5 Marks)

ii) Let $f(t) = \begin{cases} 0, & -2 < t < 0 \\ t, & 0 < t < 2 \end{cases} \qquad f(t+4) = f(t)$

a) Sketch a graph of $f(t)$ in the interval $-4 < t < 4$. (5 Marks)

b) Find the Fourier series representation of $f(t)$. (30 Marks)

c) Use the series in b) to obtain the following :

$$\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots$$ (10 Marks)

4.

i) Let X be a continuous random variable with the probability density function given by

$$f(x) = \begin{cases} kx^2(1-x); & 0 \le x \le 1 \\ 0; & \text{otherwise} \end{cases}$$

a) Find the value of k. (7 Marks)

b) Find the expected value $E(X)$. (9 Marks)

c) Find the variance $V(X)$. (9 Marks)

ii) A factory produces rechargeable batteries whose lifetimes are normally distributed with a mean of 50 hours and a standard deviation of 5 hours.

a) What is the probability that a randomly selected battery will last more than 56 hours? (7 Marks)

b) What is the probability that a battery will last between 45 hours and 53 hours? (10 Marks)

c) If the probability that a battery lasts longer than t hours is 0.0668, find the value of t. (8 Marks)

iii) An engineer measures the tensile strength (in kN) of a sample of 10 steel rods produced in a factory. Assume that the tensile strengths are normally distributed. The observed values are:

42, 45, 44, 43, 46, 41, 45, 44, 43, 47

Let the tensile strength of rod i be denoted by x_i. Suppose it is given

that $\sum_{i=1}^{10} x_i = 440$ and $\sum_{i=1}^{10} x_i^2 = 19410$.

Construct a 95% confidence interval for the population variance of the tensile strength. (25 Marks)

iv) An industrial engineer claims that the mean diameter of bolts produced by a machine is 10.0 mm. A random sample of 40 bolts is selected, and the sample mean diameter is found to be 9.85 mm. The population variance is known to be 0.36 mm^2.

At the 5% significance level, test whether there is sufficient evidence to conclude that the mean diameter is different from 10.0 mm.

(25 Marks)

Additional Information

Partial Derivatives

$$D = f_{xx}f_{yy} - (f_{xy})^2$$

Vector Calculus

The gradient of the scalar field $\phi = f(x, y, z)$ is grad $\phi = \underline{\nabla}\phi = \frac{\partial\phi}{\partial x}\underline{i} + \frac{\partial\phi}{\partial y}\underline{j} + \frac{\partial\phi}{\partial z}\underline{k}$

Consider the vector field $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$. div $\underline{F} = \frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z}$.

The curl of the vector field given by $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$ is defined as the vector field

$$\text{curl } \underline{F} = \underline{\nabla} \times \underline{F} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_1 & F_2 & F_3 \end{vmatrix}$$

Fourier Series

$$a_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\cos\left(\frac{2n\pi t}{T}\right) dt \qquad n = 0, 1, 2\ldots$$

$$b_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\sin\left(\frac{2n\pi t}{T}\right) dt \qquad n = 1, 2\ldots$$

These integrals give the Fourier coefficients for a function of period T whose Fourier series is

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left\{a_n\cos\left(\frac{2n\pi t}{T}\right) + b_n\sin\left(\frac{2n\pi t}{T}\right)\right\}$$

Continuous Random Variable

Let X be a continuous random variable with associated pdf $f(x)$. Then its expectation and variance denoted by $\mathsf{E}(X)$ (or μ) and $\mathsf{V}(X)$ (or σ^2) respectively are given by:

$$\mu = \mathsf{E}(X) = \int_{-\infty}^{\infty} x\, f(x)dx$$

and

$$\sigma^2 = \mathsf{V}(X) = \int_{-\infty}^{\infty}(x-\mu)^2 f(x)dx = \int_{-\infty}^{\infty} x^2 f(x)dx - \mu^2$$

Point Estimation

We estimate μ using the sample mean: $\bar{y} = \frac{\sum y_i}{n}$

We estimate σ^2 using the sample variance:

$$s^2 = \frac{1}{n-1}\sum(y_i - \bar{y})^2 = \frac{1}{n-1}\left\{\sum y_i^2 - \frac{1}{n}\left[\sum y_i\right]^2\right\}$$

Interval Estimation

It follows that if we do not know the population variance, we must use the estimate $\hat{\sigma}$ in place of σ. Our 95% and 99% confidence intervals (for large samples) become

$$\bar{x} - 1.96\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 1.96\frac{\hat{\sigma}}{\sqrt{n}} \quad \text{and} \quad \bar{x} - 2.58\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 2.58\frac{\hat{\sigma}}{\sqrt{n}}$$

where

$$\hat{\sigma}^2 = \frac{\sum(x - \bar{x})^2}{n-1}$$

If $x_1, x_2, x_3, \cdots, x_n$ is a random sample with variance S^2 taken from a normal population with variance σ^2 then a $100(1-\alpha)\%$ confidence interval for σ^2 is

$$\frac{(n-1)S^2}{\chi^2_{\alpha/2,n-1}} \leq \sigma^2 \leq \frac{(n-1)S^2}{\chi^2_{1-\alpha/2,n-1}}$$

where $\chi^2_{\alpha/2,n-1}$ and $\chi^2_{1-\alpha/2,n-1}$ are the appropriate right-hand and left-hand values respectively of a chi-squared distribution with $n-1$ degrees of freedom.

Test Concerning Two Samples (Unknown But Equal Variances)

$$T = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_c\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

will follow Student's t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

$$S_c^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

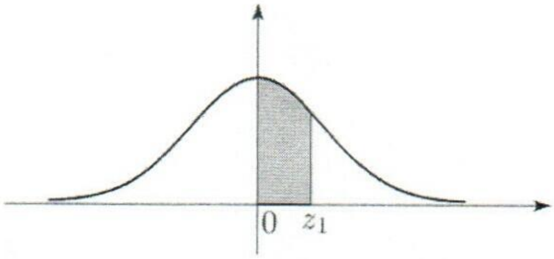
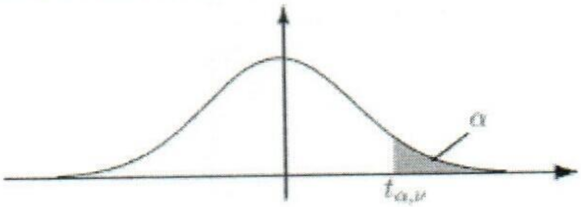


Figure 3

Table 1: The Standard Normal Probability Integral

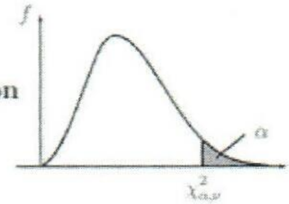
$Z = \frac{x-\mu}{\sigma}$	0	1	2	3	4	5	6	7	8	9
0	0000	0040	0080	0120	0160	0199	0239	0279	0319	0359
.1	0398	0438	0478	0517	0577	0596	0636	0675	0714	0753
.2	0793	0832	0871	0909	0948	0987	1026	1064	1103	1141
.3	1179	1217	1255	1293	1331	1368	1406	1443	1480	1517
.4	1555	1591	1628	1664	1700	1736	1772	1808	1844	1879
.5	1915	1950	1985	2019	2054	2088	2123	2157	2190	2224
.6	2257	2291	2324	2357	2389	2422	2454	2486	2517	2549
.7	2580	2611	2642	2673	2703	2734	2764	2794	2822	2852
.8	2881	2910	2939	2967	2995	3023	3051	3078	3106	3133
.9	3159	3186	3212	3238	3264	3289	3315	3340	3365	3389
1.0	3413	3438	3461	3485	3508	3531	3554	3577	3599	3621
1.1	3643	3665	3686	3708	3729	3749	3770	3790	3810	3830
1.2	3849	3869	3888	3907	3925	3944	3962	3980	3997	4015
1.3	4032	4049	4066	4082	4099	4115	4131	4147	4162	4177
1.4	4192	4207	4222	4236	4251	4265	4279	4292	4306	4319
1.5	4332	4345	4357	4370	4382	4394	4406	4418	4429	4441
1.6	4452	4463	4474	4484	4495	4505	4515	4525	4535	4545
1.7	4554	4564	4573	4582	4591	4599	4608	4616	4625	4633
1.8	4641	4649	4656	4664	4671	4678	4686	4693	4699	4706
1.9	4713	4719	4726	4732	4738	4744	4750	4756	4761	4767
2.0	4772	4778	4783	4788	4793	4798	4803	4808	4812	4817
2.1	4821	4826	4830	4834	4838	4842	4846	4850	4854	4857
2.2	4861	4865	4868	4871	4875	4878	4881	4884	4887	4890
2.3	4893	4896	4898	4901	4904	4906	4909	4911	4913	4916
2.4	4918	4920	4922	4925	4927	4929	4931	4932	4934	4936
2.5	4938	4940	4941	4943	4946	4947	4948	4949	4951	4952
2.6	4953	4955	4956	4957	4959	4960	4961	4962	4963	4964
2.7	4965	4966	4967	4968	4969	4970	4971	4972	4973	4974
2.8	4974	4975	4976	4977	4977	4978	4979	4979	4980	4981
2.9	4981	4982	4982	4983	4984	4984	4985	4985	4986	4986
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	4987	4990	4993	4995	4997	4998	4998	4999	4999	4999

Table 2: Percentage Points of the Students t-distribution



α / ν	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
1	.325	1.000	3.078	6.314	12.706	31.825	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.902	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.514	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.487
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Table 3 : **Percentage Points $\chi^2_{\alpha,v}$ of the χ^2 distribution**



α	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.025	0.010	0.005
v											
1	0.00	0.00	0.00	0.00	0.02	0.45	2.71	3.84	5.02	6.63	7.88
2	0.01	0.02	0.05	0.01	0.21	1.39	4.61	5.99	7.38	9.21	10.60
3	0.07	0.11	0.22	0.35	0.58	2.37	6.25	7.81	9.35	11.34	12.28
4	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	0.68	0.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	31.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

\- End of Examination Paper –

Library

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CINEC CAMPUS
Beyond A Graduate

Faculty of Engineering & Technology

Department of Interdisciplinary Studies

BEng

Mechanical/Automotive/Civil/Electronic/Mechatronic Engineering

Module Code	:	**FE2601**
Module Title	:	**Fundamental Mathematics and Physics**
Date	:	**13th of May 2026**
Examiner	:	**Mr. V.P.V. Tharaka**
Time Allowed	:	**2 hours**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of 2 parts. Answer all questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- You are allowed to use a calculator.

Part 1- Mathematics

1. a) Find the composite functions fog and gof, given 2 marks

$$f(x) = x^3 + 1$$
$$g(x) = x^2 - 1$$

b) Solve the following set of simultaneous equations: 2 marks

$$x + 2y = 11$$

$$5x - 4y = 13$$

What is the method that you used there? Elimination method or substitution method? 1 mark

c) Solve the following quadratic equation. 4 marks

$$x^2 - 3x - 10 = 0$$

d) A company calculates that its profit (P) in Dollars ($) from selling (x) units of a product is ($P = -2x^2 + 120x - 1000$). How many units must they sell to make a profit of ($800\)?

3 marks

2. a) According to the laws of exponents, simplify the following expression: 2 marks

$$\left(\frac{2x^5 \times x^{-3}}{4x^2}\right)$$

b) Solve the following equation for x : 6 marks

$$\log_2(x + 1) + 2 = \log_2(x - 2)$$

c) Determine the equation of the following straight line.

- A line with gradient −3 that passes through the point (0, 2). 4 marks

3. a) Differentiate the following functions. 4 marks

i. $f(x) = \frac{\ln x}{x^2+3}$

ii. $f(x) = \ln(2x^3+1)$

b) Let $y = x^3 + 3x^2 - 9x + 1$,

i. Determine the first derivative (y'). 4 marks

ii. Determine the second derivative (y'').

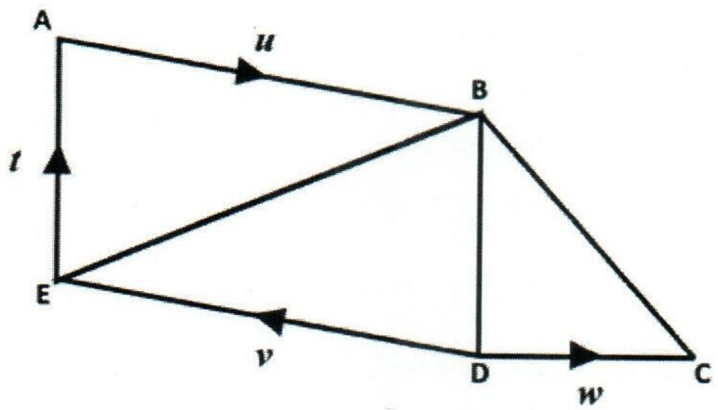
c) Use integration by parts to evaluate, $\int 3xe^{2x}\,dx$.

5 marks

d) Use partial fractions to evaluate, $\int \frac{x^2-x+2}{x^2-2x-3}\,dx$.

4 marks

4. a) Find the given vectors in terms of $\boldsymbol{t}, \boldsymbol{u}, \boldsymbol{v}$ and $\boldsymbol{w}$. 3 marks



I. $\overrightarrow{EB}$ II. $\overrightarrow{BD}$ III. $\overrightarrow{BC}$

b) The position vectors of points A and B, relative to the origin O, are $\underline{a}$ and $\underline{b}$, respectively. Point C lies on AB such that AC : CB = 2 : 3. Point D lies on OC such that OD : DC = 1 : 3. Find the position vectors of C and D, and hence find the vector $\overrightarrow{AD}$. 6marks

[Total 50 marks]

Part 2- Physics

1. Figure 1.1 shows the velocity-time graph for a bike travelling on a straight horizontal road.

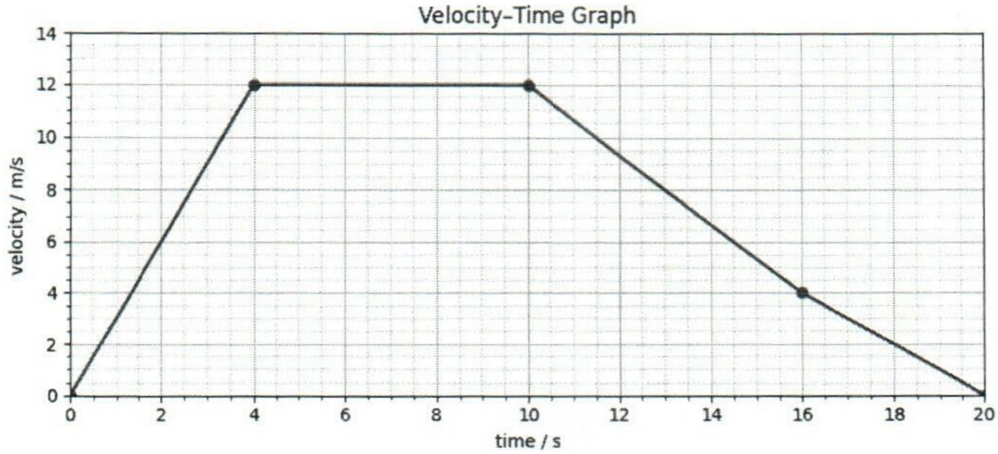


Figure 1.1

Find the following using the graph.

a) Acceleration in the first 4s.

b) Acceleration between 10s and 16s.

c) Acceleration in the last 4s.

d) Total distance travelled in first 10s.

e) Total distance travelled between 10s and 16s.

f) Total distance travelled in the last 4s.

g) Total distance travelled in entire motion in 20s.

16 marks

2. A person is pushing a box of mass 25 kg in the upward direction of a plane of inclined at 30° to the horizontal. He applies a force of 200N to the upward direction parallel to the plane. The friction coefficient between the box and the plane is $\frac{2}{5\sqrt{3}}$ as shown in the Figure 2.1.
(Take gravitational acceleration as 10 ms^{-2})

a) State Newton's Second Law of Motion.

b) Show that the frictional force between the plane and the box is 50 N.

c) Calculate the component of the weight acting down the plane.

d) Calculate the acceleration of the box along the plane.

If it starts from rest,

e) Calculate the speed of the box after 3s.

f) Calculate the displacement of the box after 3s along the plane.

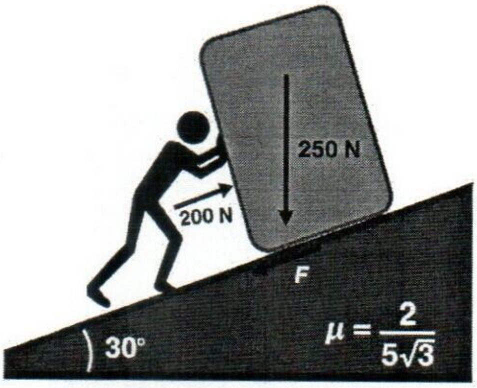


Figure 2.1

14 marks

4. a) A sample of ideal gas is initially at pressure 1.5×10^5 Pa, volume 0.010 m³, and temperature 300 K.
   The gas undergoes two processes.

   Process 1 → 2 : The gas expands isothermally until its volume becomes 0.020 m³.

   Process 2 → 3 : The gas is compressed at constant pressure until its volume becomes 0.010 m³.

   Answer the following:

i.	Calculate the number of moles of gas.	2 marks
ii.	Calculate the pressure at state 2.	2 marks
iii.	Sketch the process on a P-V diagram.	4 marks
iv.	State the temperature at state 2.	1 marks
v.	Calculate the temperature at state 3.	1 marks
vi.	Calculate the work done during process 2 → 3. Clearly state the sign convention used.	2 marks

   b) A copper electrical transmission cable is installed between two poles. At 25°C, the length of the cable is 60 m. During a hot afternoon, the temperature of the cable rises to 75°C. The coefficient of linear expansion of copper is 1.7×10^{-5} °C^{-1}.

i.	Calculate the temperature change of the cable.	2 marks
ii.	Calculate the increase in length of the copper cable.	4 marks
iii.	Calculate the final length of the cable at 75°C.	2 marks

[Total 50 marks]

EQUATION SHEET

Table of derivatives

function $f(x)$	derivative $\frac{df}{dx}$ or $f'(x)$	
c	0	c is any constant
x	1	
$2x$	2	
x^n	nx^{n-1}	n is any real number
$\sin x$	$\cos x$	
$\cos x$	$-\sin x$	
e^x	e^x	
$\ln x$	$\frac{1}{x}$	

Chain rule

If $z = g(x)$ and $y = f(z)$ then: $\frac{dy}{dx} = \frac{dy}{dz} \cdot \frac{dz}{dx} = f'(z) \cdot g'(x)$

Table of integrals

$f(x)$	$\int f(x)\,dx$	
k, any constant	$kx + c$	
x	$\frac{x^2}{2} + c$	
x^2	$\frac{x^3}{3} + c$	
x^n	$\frac{x^{n+1}}{n+1} + c$	$n \neq -1$
$x^{-1} = \frac{1}{x}$	$\ln\lvert x\rvert + c$	
e^x	$e^x + c$	
e^{kx}	$\frac{1}{k}e^{kx} + c$	
$\cos x$	$\sin x + c$	
$\cos kx$	$\frac{1}{k}\sin kx + c$	
$\sin x$	$-\cos x + c$	
$\sin kx$	$-\frac{1}{k}\cos kx + c$	
$\tan x$	$\ln(\sec x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\sec x$	$\ln(\sec x + \tan x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\operatorname{cosec} x$	$\ln(\operatorname{cosec} x - \cot x) + c$	$0 < x < \pi$
$\cot x$	$\ln(\sin x) + c$	$0 < x < \pi$
$\cosh x$	$\sinh x + c$	
$\sinh x$	$\cosh x + c$	
$\tanh x$	$\ln\cosh x + c$	
$\coth x$	$\ln\sinh x + c$	$x > 0$
$\frac{1}{x^2+a^2}$	$\frac{1}{a}\tan^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{x^2-a^2}$	$\frac{1}{2a}\ln\frac{x-a}{x+a} + c$	$\lvert x\rvert > a > 0$
$\frac{1}{a^2-x^2}$	$\frac{1}{2a}\ln\frac{a+x}{a-x} + c$	$\lvert x\rvert < a$
$\frac{1}{\sqrt{x^2+a^2}}$	$\sinh^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{\sqrt{x^2-a^2}}$	$\cosh^{-1}\frac{x}{a} + c$	$x \geqslant a > 0$
$\frac{1}{\sqrt{x^2+k}}$	$\ln(x + \sqrt{x^2+k}) + c$	
$\frac{1}{\sqrt{a^2-x^2}}$	$\sin^{-1}\frac{x}{a} + c$	$-a \leqslant x \leqslant a$

$$Gravitational\ Acceleration = 9.8m/s^2$$

$$v = u + at$$

$$x - x_0 = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2a(x - x_0)$$

$$x - x_0 = \frac{1}{2}(u + v)t$$

$$F = ma$$

$$F_s = \mu_s n$$

$$F_k = \mu_k n$$

$$x = r\theta$$

$$v_{tan} = r\omega$$

$$a_{tan} = r\alpha$$

$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$$

$$F_c = \frac{mv^2}{r}$$

$$\rho = mv$$

$$I = m\Delta v$$

$$W = Force\ \times displacement$$

$$W = F cos\theta\ \times displacement$$

$$E_{Kinetic} = \frac{1}{2}mv^2$$

$$E_{Potetial} = mgh$$

$$E_{spring} = \frac{1}{2}kx^2$$

$$W_{net} = \Delta E_{Kinetic}$$

$$W_{NC} = \Delta E_{Kinetic} + \Delta E_{Potential}$$

$$\Delta L = \alpha L \Delta T$$

CINEC CAMPUS
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Faculty of Engineering & Technology **Department of Interdisciplinary Studies** **BSc. Hons. (Eng.) in Automotive/Mechanical/Electronic/Mechatronic/Civil Engineering** **Semester 2 Final Examination 2026** **Batch :8**	
Module Code: FE1227	**Module Title: Meditation and Stress Management**
Date: 09.05.2026	**Duration: 3 hours**
Examiner :	**Ms.Yamuna Samarakoon**

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four 5 questions and 2 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 Undergraduates often face difficulties in maintaining regular meditation practice.

i) Identify **three common challenges** and explain why they occur. [10]

ii) Discuss how you can personally overcome these challenges using practical strategies. [10]

Total [20]

Q2 Tranquility meditation involves a series of steps that develop concentration and calmness.

i) Describe the step-by-step process of tranquility meditation. [6]

ii) Explain how each stage contributes to developing concentration and calmness. [6]

iii) Support your answer with examples from **your personal experience**. [8]

Total [20]

Q3 Maintaining a consistent meditation practice requires certain personal qualities

i) Identify and explain **four** key qualities necessary for regular meditation practice. [10]

ii) Reflect on your own experience and discuss **one quality you are currently developing**. [10]

Total [20]

Q4 Meditation practices can contribute significantly to emotional balance in daily life.

i) Discuss how **tranquility meditation or insight meditation** supports emotional balance. [10]

ii) Explain how these practices influence both the **mind and the body**, using relevant examples. [10]

Total [20]

Q5 Insight meditation plays an important role in developing self-awareness.

i) Explain how insight meditation enhances awareness of thoughts and emotions. [10]

ii) Discuss how this awareness can improve decision-making and emotional regulation, using examples to support your answer. [10]

Total [20]

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Faculty of Engineering & Technology

Department of Interdisciplinary Studies

BSc. Hons. (Eng.) in Automotive/Mechanical/Electronic/Mechatronic/Civil Engineering

Semester 2 Final - Examination 2026

Batch : 8

Module Code: FE1321	**Module Title: Engineering Mathematics II**
Date: 20.04.2026	**Duration: 3 hours**
Examiner :	**Ms.Shannon Wijeratne**

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four 4 questions and 5 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 **i)** Consider the following system of equations:

$$x - 2y + 3z = 7$$

$$4 + 5y - z = -3$$

$$-2x + 4y - 6z = -14$$

a) Find the ranks of the augmented matrix and the coefficient matrix. [25]

b) Determine the nature of solutions for the above system. [5]

c) Determine the solutions if they exist. [13]

ii) Consider the following matrix:

$$A = \begin{pmatrix} 2 & 0 & 1 \\ -1 & 4 & -1 \\ -1 & 2 & 0 \end{pmatrix}$$

a) Find the characteristic polynomial of the above matrix. [12]

b) Find the eigenvalues of A. [9]

c) Find the corresponding eigenvectors of A. [30]

d) Find the normalized eigenvectors of A. [3]

e) Deduce the eigenvalues of A - 3I , using the eigenvalues of the matrix A, where I is the 3X3 identity matrix. [3]

Total [100]

Q2 i) Find the general/particular solution for each of the following differential equations using a **suitable method** and keep your answers in the **most simplified form**:

a) $(y^2 - 1)\ \frac{dy}{dx} = 2y$ given $y = 1$ when $x = \frac{11}{6}$. [12]

b) $(2026 + 4x^2)\ \frac{dy}{dx} = 20x(1 + y^2)$ [10]

c) $x\ \frac{dy}{dx} = \frac{x^2+y^2}{y}$ given $y = 4$ when $x = 1$ [20]

d) $\frac{dy}{dx} - \frac{4y}{(x+1)} = 2(x+1)^3$ [15]

e) $4xy\frac{dy}{dx} = y^2 - 1$ [10]

ii) Aluminium conductor found in a circuit seems to change its resistance (R) with the temperature (θ). The change in resistance with respect to temperature is proportional to the resistance of the aluminium conductor.

a) Form a differential equation to find the **resistance at a given temperature**. (Consider the constant of proportionality as k which is the temperature coefficient of resistance of aluminium). [5]

b) If $R = R_0$ when $\theta = 0^0C$, solve the differential equation for R. [20]

c) If $k = 43 \times 10^{-4}/^0C$ determine the resistance of the aluminium conductor at 80^0C correct to 4 significant figures, given that the resistance is 32 Ω at 0^0C. [8]

Total [100]

Q3. i) Calculate the radius of curvature(R) at the point (-1, 3) on the curve whose equation is $y = x + 3x^2 - x^3$ and hence obtain the coordinates of the center of curvature. [20]

$$\left(\text{Hint: Use} \quad R = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}{\left|\frac{d^2y}{dx^2}\right|} \right)$$

ii) Find the limit of each of the following sequences and state whether each is convergent or divergent:

a) $\lim_{n\to\infty} \left(\frac{3n+2}{4n+3}\right)^n$ [8]

b) $\lim_{n\to\infty}(-1)^n \frac{2n+1}{n^2+n}$ [12]

iii) Determine whether each of the following series is convergent or divergent:

a) $\sum_{n=0}^{\infty} \frac{3^{n+1}n!}{4^n}$ using the ratio test. [13]

b) $\sum_{n=0}^{\infty} \frac{(-1)^n}{n^3+4n+1}$ using the alternating series test. [12]

iv) Determine the radius of convergence and the interval of convergence for the following power series:

$$\sum_{n=0}^{\infty} \frac{(x+3)^n}{n+2}$$ [20]

v) Find the Maclaurin series of $f(x) = x^2e^{-x}$. [15]

Total [100]

Q4 i) Consider the following set of vectors:

$$\left\{ \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \\ 5 \end{pmatrix}, \begin{pmatrix} 1 \\ 4 \\ \alpha \end{pmatrix} \right\}$$

a) Find the value of α for which the above vectors become linearly dependent. [15]

b) If $\alpha = 2$,find a basis for the space spanned by the above vectors and find whether they are orthogonal. [25]

ii) Determine whether the vectors V_1= (1,4,-3), V_2= (-2,1,5) and V_3= (4,7,-11) span $\mathbb{R}^3$? [15]

iii) Let A and B be the following bases for $\mathbb{R}^2$:

$$A = \left\{ \begin{pmatrix} 1 \\ -1 \end{pmatrix}, \begin{pmatrix} -3 \\ 2 \end{pmatrix} \right\} \quad \text{and} \quad B = \left\{ \begin{pmatrix} 2 \\ -1 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix} \right\}$$

a) Find the change of basis matrix $P_{B \to A}$ from B to A. [25]

b) Let $v = \begin{bmatrix} 3 \\ 4 \end{bmatrix}$ with respect to the basis B. Find the coordinates of v with respect to the basis A. [20]

Total [100]

Faculty of Engineering & Technology

Department of Interdisciplinary studies

STEM Foundation

Semester 2 - In class Test 4

Module Code	:	**STEM 1511**
Module Title	:	**Foundation Mathematics II**
Date	:	**7th April 2026**
Examiner	:	**Dr. Shelton Perera**
Time Allowed	:	**(9:00 am – 11:00 am) - 2 hours**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of five (06) questions. Answer all six questions.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- You may use a Scientific calculator. This must not be programmable and may be inspected during the examination.

1. Express each of the following in $a + ib$ form, where a and b are real numbers:

   (i) $2(3 - i) - (2 - 3i)$,

   (ii) $(3 - 4i)(2 + 3i)$,

   (iii) $(2 + i)^2 - (1 - 2i)^2$,

   (iv) $\frac{1-3i}{1+2i}$,

   (v) $\frac{(2+i)(3-4i)}{(1-2i)}$. [25 Marks]

2. (a) Find the values of the real numbers p and q such that

$$(p + 2i)(q - i) = 5 + 5i.$$ [15 Marks]

   (b) Let $z = \frac{2+pi}{1-3i}$, where p is a real number. It is given that $|z| = 2$.

   Find the value of p. [10 Marks]

3. Let A, B and C be three events of a sample space S such that A and B are Independent, B and C are mutually exclusive, $P(A) = \frac{1}{4}, P(C) = \frac{1}{6}$ and $P(B \cup C) = \frac{1}{2}$. Find $P(A \cup B)$. [10 Marks]

4. A group of 8 students consists of 5 boys and 3 girls. Two students are selected at random.

   (i) Find the probability that selected students are boys.

   (ii) Find the probability that at least one of the selected students is a girl. [15 Marks]

5. A bag contains 4 white balls and 3 black balls. Two balls are drawn at random without replacement.

   (i) Find the probability that the two balls are of different colours.

   (ii) Given that the second ball drawn is white, find the probability that the first ball is black. [15 Marks]

6. Find the area bounded by the curves $y = x^2$ and $y = x + 2$. [10 Marks]

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Faculty of Engineering & Technology Department of Interdisciplinary Studies BSc. Hons. (Eng.) in Automotive/Mechanical/Electronic/Mechatronic/Civil Engineering Semester 7 Final - Examination 2026 Batch : 5	
Module Code: FE4312	**Module Title: Engineer as an Entrepreneur**
Date: 06.04.2026	**Duration: 3 hours**
Examiner :	**Dr. Anura Priyantha**

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of five (05) questions and 03 pages. Answer all questions.*
- *Read each question carefully before answering.*
- *Use relevant engineering, business, and real-world examples where appropriate*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 Nimal Fernando, a mechanical engineering graduate in Sri Lanka, worked for several years in the logistics and warehousing sector, particularly supporting port operations and inland container depots. During his experience, he observed that many small- and medium-scale logistics providers still rely on fragmented systems such as manual documentation, phone-based coordination, and disconnected spreadsheets to manage container tracking, fleet scheduling, and warehouse inventory.

These inefficiencies often resulted in delayed deliveries, poor asset utilization, lack of real-time visibility, and increased operational costs. With the rapid growth of Sri Lanka's logistics sector and increasing pressure for digital transformation, Nimal identified a significant opportunity to introduce a cloud-based logistics management platform tailored for local SMEs.

After conducting preliminary discussions with logistics operators, freight forwarders, and warehouse managers, Nimal conceptualized a solution that integrates GPS tracking, digital documentation, inventory management, and real-time analytics into a single user-friendly platform. He also considered incorporating mobile applications for drivers and site supervisors to improve field-level coordination.

However, Nimal faced several challenges, including resistance to technology adoption among traditional operators, initial development costs, data security concerns, and competition from international software providers. Despite these challenges, he remained confident that a locally adapted, cost-effective solution could create significant value in the Sri Lankan market.

Based on the above case, answer the following:

a) Identify and explain three (03) key entrepreneurial or technopreneurial characteristics demonstrated by Nimal Fernando [06]

b) Identify and discuss the specific market gap or business opportunity recognized by Nimal. [06]

c) Examine the process of idea generation and opportunity validation used by Nimal. [08]

d) Conduct a feasibility analysis of the proposed venture covering technical, financial, and operational aspects. [08]

e) Perform an industry analysis of the Sri Lankan logistics and supply chain sector relevant to this business idea, highlighting competitive forces and growth potential. [12]

Total [40]

Q2. A startup intends to introduce a low-cost energy monitoring system for manufacturing industries in Sri Lanka. The system aims to help factories monitor energy consumption in real time and reduce operational costs.

a) Describe how the entrepreneur can conduct comprehensive market research (both primary and secondary) to assess feasibility and demand. [04]

b) Explain how customer segmentation (e.g., industry type, factory size, energy Usage patterns) influences product design and marketing strategy. [05]

c) Discuss practical approaches to managing customer expectations and delivering service excellence for a technology-based product. [06]

Total [15]

Q3. a) Explain the concept of a business model and its importance for a technology-based startup. [04]

b) Compare two financing options available for startups (e.g., bank loans vs venture capital / angel investors vs bootstrapping), highlighting advantages and risks. [05]

c) Explain the importance of financial planning and cash flow management in early-stage startups with suitable examples. [06]

Total [15]

Q4. An engineering startup has successfully launched its product and is now entering a rapid growth phase, requiring expansion of its workforce, operations, and market reach.

a) Discuss the importance of leadership and team dynamics during the growth stage, particularly in maintaining productivity and innovation [03]

b) Identify three key challenges in managing human resources in a growing startup and propose practical solutions. [06]

c) Explain how organizational culture and strategic decision-making influence long-term sustainability, competitive advantage, and strategic growth of an engineering startup, providing relevant examples. [06]

Total [15]

Q5. Write short notes on the following:

a) Necessity-driven vs Opportunity-driven entrepreneurship [05]

b) SWOT Analysis [05]

c) Financial Stability in a startup context [03]

d) Niche Marketing [02]

Total [15]

Faculty of Engineering & Technology
Department of Interdisciplinary Studies

STEM Foundation
Semester 2 - In Class Test 04

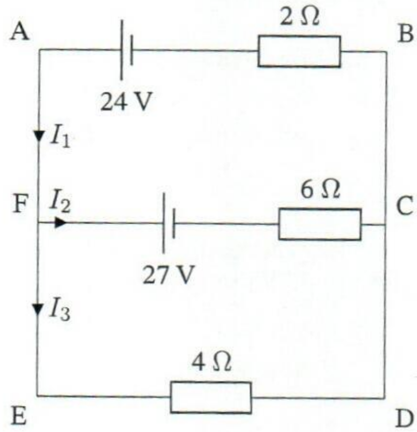
Module Code	:	STEM1512
Module Title	:	Practical Engineering Science for Electro-Mechanical Design
Date	:	26th March 2026
Examiners	:	K.D.Sachintha Madhawa / H.D.C.N.Gunawardana
Time Allowed	:	(01.00 pm - 3.00 pm) - 2 hrs.

Instructions to Candidates:

- ⋆ *This is a closed book examination. No reference materials are allowed.*
- ⋆ *This paper consists of four (04) questions. Answer **all Four** questions.*
- ⋆ *Use only the provided answer sheets for your answers.*
- ⋆ *Write clearly and legibly using a blue or black pen.*
- ⋆ *Write your student number on all sheets.*
- ⋆ *Start each question on a new page in the answer booklet. Clearly indicate the question number.*
- ⋆ *Where appropriate, include clear diagrams or sketches. Marks will be deducted for missing units.*
- ⋆ *Usage of mobile phones during the assessment is strictly prohibited.*

You may use a scientific calculator, but it must not be programmable.

1. Apply Kirchhoff's laws to the circuit shown below to determine the unknown currents.



a) Write down the Kirchhoff's Current Law (KCL) equation for node F. [5 marks]

b) Write down the Kirchhoff's Voltage Law (KVL) equations for the top loop (A-B-C-F-A) and the bottom loop (F-C-D-E-F). [10 marks]

c) Calculate the exact values of the currents I_1, I_2, and I_3. [10 marks]

[Total: 25 marks]

2. A circuit consists of a resistor connected in series with a 0.5μF capacitor and has a time constant of 12 ms. The combination is connected to a 10 V DC supply to charge the capacitor.

a) Determine the value of the unknown resistor R in the circuit. [5 marks]

b) Write down the equation governing the voltage across the capacitor, $V(t)$, as it charges. [5 marks]

c) Calculate the capacitor voltage exactly 7 ms after connecting the circuit to the voltage supply. [10 marks]

d) What is the maximum charge Q_{max} that this capacitor will eventually store if left connected indefinitely? [5 marks]

[Total: 25 marks]

3. A 50 mH inductor is connected in series with a 100 Ω resistor and a 24 V DC power supply. A switch is closed at time $t = 0$, allowing the inductor to begin charging.

a) Determine the time constant τ of this RL circuit. [5 marks]

b) Calculate the maximum steady-state current (I_{max}) that will eventually flow through the circuit. [5 marks]

c) Write down the equation for the current $I(t)$ as a function of time. [5 marks]

d) What is the current flowing in the circuit exactly 1.0 ms after the switch is closed? [5 marks]

e) Calculate the maximum energy that will be stored in the inductor's magnetic field once steady-state is reached. [5 marks]

[Total: 25 marks]

4. A full-wave bridge rectifier uses four identical Silicon diodes and is connected to an AC supply with a peak voltage of 15 V at 50 Hz. The load resistor is 50 Ω.

a) Draw a circuit diagram of the full-wave bridge rectifier, clearly showing all four diodes, the AC source, and the load resistor. [6 marks]

b) Explain which diodes conduct during the positive half-cycle and which conduct during the negative half-cycle. [4 marks]

c) Calculate the peak output voltage across the load resistor (accounting for the voltage drop across two Silicon diodes, assuming a 0.7V drop per diode). [5 marks]

d) Calculate the average DC output voltage. [5 marks]

e) State three advantages of a full-wave bridge rectifier over a half-wave rectifier. [5 marks]

[Total: 25 marks]

Formula Sheet

1. Basic Electricity & DC Circuits	2. Capacitors (RC Circuits)
$V = IR$ $P = VI = I^2R = \frac{V^2}{R}$ $E = P \times t$ $R = \rho\frac{L}{A} \quad ; \quad A = \frac{\pi d^2}{4}$ $G = \frac{1}{R}$ $R_{series} = R_1 + R_2 + \cdots + R_n$ $\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$	$\tau = RC$ $V_C(t) = V_s\left(1 - e^{-\frac{t}{\tau}}\right)$ (Charging) $V_C(t) = V_0 e^{-\frac{t}{\tau}}$ (Discharging) $Q = CV$ $E = \frac{1}{2}CV^2$
3. Inductors (RL Circuits)	**4. Diodes & Rectification**
$\tau = \frac{L}{R}$ $I(t) = I_{max}\left(1 - e^{-\frac{t}{\tau}}\right)$ (Charging) $I_{max} = \frac{V_s}{R}$ $E = \frac{1}{2}LI^2$	Full-Wave Peak: $V_{p(out)} = V_{p(in)} - 2V_d$ Full-Wave DC: $V_{dc} = \frac{2V_{p(out)}}{\pi} \approx 0.636V_{p(out)}$ Half-Wave Peak: $V_{p(out)} = V_{p(in)} - V_d$ Half-Wave DC: $V_{dc} = \frac{V_{p(out)}}{\pi} \approx 0.318V_{p(out)}$

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Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication/ Mechatronics/ Mechanical/ Civil/ Automotive Engineering
Batch 7 Semester 2 Resit Examination 2025

Module Code	:	**EE1325**
Module Title	:	**Programming Fundamentals**
Date	:	**11.03.2026**
Examiners	:	**Ms. Rangi Dahanayake**
Time Allowed	:	**3 Hours**

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 5 questions. You Should Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains 3 pages.

MATERIALS REQURIED

- CINEC answering Booklet; Extra answering paper
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Question 01 (20 Marks)

a. Draw a flowchart to calculate the total rainfall over several days entered by the user. The program should continue accepting daily rainfall amounts until the user enters a negative number, after which it should stop and display the total rainfall. (5 Marks)

b. Write a program to determine the smallest of three given temperatures using conditional statements. (5 Marks)

c. Write a program to display the message:

Practice
Makes
You
A
Better
Coder

Each word should be printed on a separate line. (There should be six (06) lines.) (5 Marks)

d. Write a program to take input of a product's weight and display it rounded to exactly two (02) decimal places, such as 12.34. (5 Marks)

Question 02 (20 Marks)

a. Write a program to determine eligibility for applying for a driving license based on the following criteria:

Eligibility Criteria:

Age >= 18 and
Marks in Traffic Rules Test >= 40 and
Marks in Practical Test >= 50 or Total marks in both tests >= 100

Input the applicant's age: 19
Input the marks obtained in Traffic Rules Test: 38
Input the marks obtained in Practical Test: 55
Total marks in both tests: 93

The applicant is not eligible for a driving license.

(10 Marks)

b. Write a program that prompts the user to enter their daily expenses until they input 0. Calculate and print the total amount spent using a do-while loop. (10 Marks)

Question 03 (20 Marks)

a. Explain how arrays are used in programming to store and access a list of student marks. Give a simple example. (04 Marks)

b. Write a program to create an array of 5 integers, assign the numbers 1 to 5 to the array, and then display all the values stored in the array. (06 Marks)

c. Write a program that defines a 2x2 two-dimensional array, allows the user to input numbers for each element, and then prints the array in matrix form. (10 Marks)

Question 04 (20 Marks)

a. Write a function called greater to determine and return the larger of two floating-point numbers. The numbers should be entered by the user in the main () function and passed as arguments to the greater function.
(10 Marks)

b. Write a function called smaller to determine and return the smaller of two floating- point numbers. The numbers should also be entered in the main () function and passed to the smaller function.
(10 Marks)

Question 05 (20 Marks)

a. Write a program using a for loop to display the following pattern:

```
A
AA
AAA
AAAA
AAAAA
```
(10 Marks)

b. Explain three good programming practices that can write an efficient and a maintainable code. (4 Marks)

c. Explain the importance of keywords, "try", "catch" and "throw" in exception handling. (6 Marks)

--------------------END OF THE QUESTION PAPER----------------

Faculty of Engineering & Technology

Department of Interdisciplinary Studies

BEng

Mechanical/Automotive/Civil/Electronic/Mechatronic Engineering

Module Code	:	**FE2601**
Module Title	:	**Fundamental Mathematics and Physics**
Date	:	**20th of August**
Examiner	:	**Ms.Piyumi Hansika/Ms.Shannon Wijeratne**
Time Allowed	:	**(1.30 pm – 4.30 pm)- 3 hours**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of 2 parts. Answer all questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- You are allowed to use a calculator.

Part 1- Mathematics		
1	a) Simplify the following: i. $\frac{4}{5}$ of $2\frac{2}{5} \div 1\frac{1}{2}$ ii. $(1\frac{2}{5} \times \frac{5}{7}) + (\frac{3}{4} \div \frac{1}{2})$	2 marks
	b) Solve the following set of simultaneous equations: i. By method of substitution, $x + 3y = 13$ $5x + 4y = 21$	3 marks
	ii. By method of elimination, $2x - y = 8$ $x + 3y = 11$	3 marks
	c) Solve the following quadratic equations by using the formula: i. $x^2 - 5x + 6 = 0$ ii. $2x^2 - 3x + 1 = 0$	3 marks
	d) A man went to Hikkaduwa from Colombo which is 120 km away. On the way back, due to road construction, he had to drive 10km/h slower, which resulted in the return trip taking 2 hours longer, how fast did he drive from Colombo to Hikkaduwa?	4 marks
2	a) Find x ,(Given that $ln(5) = 1.6094$ and $ln(2) = 0.6931$.) $5^{9x-2} = 2^{x+1}$	2 marks
	b) Given that $x = 2^p$ and $y = 4^q$, show that, $log_2 (x^3 y) = 3p + 2q$	2 marks
	c) Solve the following and provide the final answer in the form of an integer: i. $\log_{10} 20 + \log_{10} 2 - \log_{10} 4$ ii. $\log_4 32 + \log_4 2$	3 marks
	d) Find the value of *x*, i. $\log_a x + \log_a (x-3) = \log_a 10$	3 marks
3	a) If $f(x) = \frac{3x^2 - 1}{4-x}$ calculate the output of the function when $x = -2$.	2 marks
	b) If $f(x) = 3x$ and $g(x) = 2x^2 - 5$ find out $g(f(x))$.	2 marks
	c) Determine the equation of straight line graph when coordinates of two given points are,	

$(3,-1)$ and $(-2,9)$

d) State the domain and the range of the following function:

i. $y = -2(x+3)^2 - 1$ — 2 marks

e) Find the inverse of the following function: — 2 marks

i. $y = 3x - 2$

2 marks

4

a) Differentiate the following functions with respect to x, using the table of derivatives and basic rules of differentiation. — 4 marks

i. $y = x^2 \ln x$

ii. $y = \frac{\sin x}{x}$

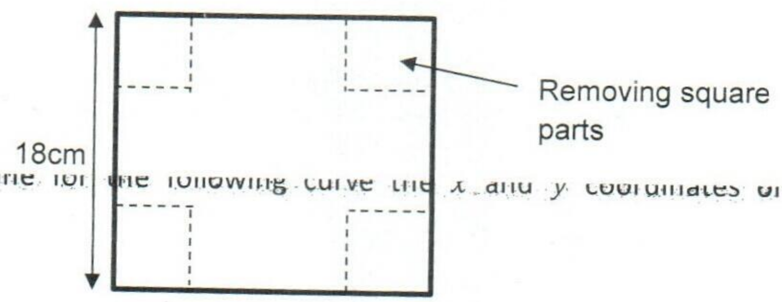
b) Determine for the following curve the x and y coordinates of any maximum or minimum point, and state with the reason whether it is a minimum or a maximum.

$$y = x^2 + 3x - 4$$

4 marks

c) A square piece of tin sheet of side 18cm is to be made into a box without top by cutting a square from each corner and folding up the flaps to form a box, what should be the side length of the square to be cut off so that the volume of the box is maximum?

Also find the maximum volume.



b) Determine for the following curve the x and y coordinates of any

5 marks

d) Determine the following definite integrals.

i. $\int_1^3 x^3 \, dx$ — 2 marks

ii. $\int_0^k 2(kv^3 - v^4)dv$

[Total 50 marks]

Part 2- Physics

1 Figure 1.1 shows the velocity–time graph for a car travelling on a straight horizontal road.

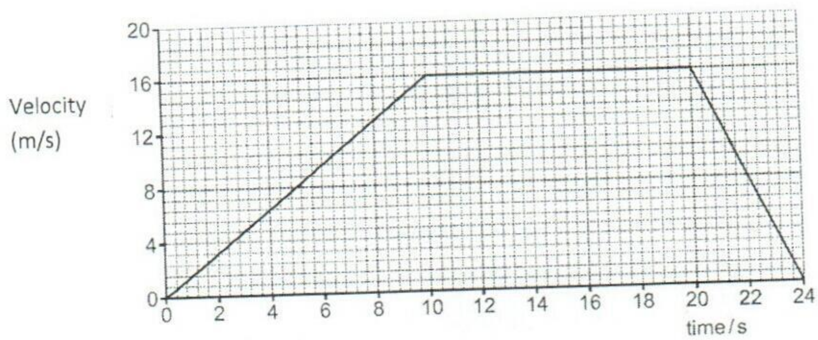


Figure 1.1

Find the following using the graph:

a) Acceleration in the first 10s — 3 marks

b) Acceleration between 10s and 20s — 3 marks

c) Acceleration in the last 4s — 3 marks

d) Total distance travelled in 10s — 3 marks

e) Total distance travelled in 24s — 3 marks

2 A person is pushing a crate with mass 50kg as given in Figure 2.1. He applies a force of 75N to the right. The force of friction on the crate is 65N to the left.

a) Write the **Newton's Third Law** — 3 marks

b) Calculate the speed of the crate after 3 seconds, if it starts from rest? — 6 marks

c) Explain the term **'kinetic friction'**. — 3 marks

d) Calculate the coefficient of kinetic friction (μ_k) between the crate and the floor. — 3 marks

Figure 2.1

3

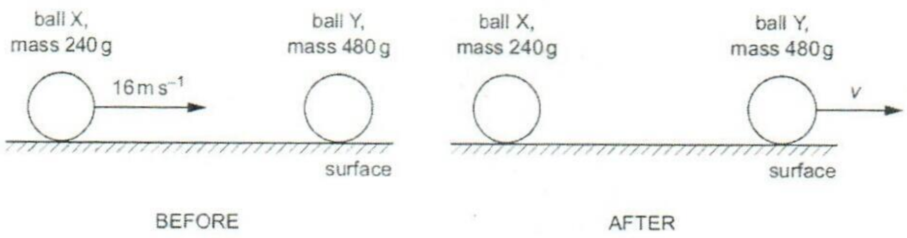


Figure 3.1

A ball X has mass 240 g and moves in a straight line on a horizontal frictionless surface with an initial speed of 16 m/s as given in Figure 3.1. The ball collides with a stationary ball Y that has mass 480 g. After the collision, ball X is stationary.

(a) Using the principal of conservation of momentum and by calculations show that the speed v of ball Y after the collision is 8.0 m/s. — 4 marks

(b) Calculate the change in the total kinetic energy ΔE_k of the balls due to the collision. — 4 marks

(c) Explain why there is a loss of kinetic energy in this collision and identify the forms into which this energy may have been transformed. — 2 marks

4

A technician uses a steel measuring tape that is **exactly 50m long** at a temperature of **20 °C** in an indoor environment.

(a) One common scale used to measure temperature is **Celsius** (°C**)**. Name the other two temperature scales that are used. — 4 marks

(b) The technician notices that the steel tape feels colder when touched than a wooden ruler stored in the same indoor environment. Explain the reason. — 2 marks

(c) Calculate the length of the steel tape if he uses it on a hot outside environment when the temperature is **35°C**. The coefficient of linear expansion (α) for steel is $1.2 \times 10^{-5}\ K^{-1}$ — 4 marks

[Total 50 marks]

EQUATION SHEET

Table of derivatives

function $f(x)$	derivative $\frac{df}{dx}$ or $f'(x)$	
c	0	c is any constant
x	1	
$2x$	2	
x^n	nx^{n-1}	n is any real number
$\sin x$	$\cos x$	
$\cos x$	$-\sin x$	
e^x	e^x	
$\ln x$	$\frac{1}{x}$	
[illegible]	[illegible]	

Chain rule

$$\text{If } z = g(x) \text{ and } y = f(z) \text{ then: } \frac{dy}{dx} = \frac{dy}{dz} \cdot \frac{dz}{dx} = f'(z) \cdot g'(x)$$

Table of integrals

$f(x)$	$\int f(x)\,dx$	
k, any constant	$kx + c$	
x	$\frac{x^2}{2} + c$	
x^2	$\frac{x^3}{3} + c$	
x^n	$\frac{x^{n+1}}{n+1} + c$	$n \neq -1$
$x^{-1} = \frac{1}{x}$	$\ln\lvert x\rvert + c$	
e^x	$e^x + c$	
e^{kx}	$\frac{1}{k}e^{kx} + c$	
$\cos x$	$\sin x + c$	
$\cos kx$	$\frac{1}{k}\sin kx + c$	
$\sin x$	$-\cos x + c$	
$\sin kx$	$-\frac{1}{k}\cos kx + c$	
$\tan x$	$\ln(\sec x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\sec x$	$\ln(\sec x + \tan x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\operatorname{cosec} x$	$\ln(\operatorname{cosec} x - \cot x) + c$	$0 < x < \pi$
$\cot x$	$\ln(\sin x) + c$	$0 < x < \pi$
$\cosh x$	$\sinh x + c$	
$\sinh x$	$\cosh x + c$	
$\tanh x$	$\ln\cosh x + c$	
$\coth x$	$\ln\sinh x + c$	$x > 0$
$\frac{1}{x^2+a^2}$	$\frac{1}{a}\tan^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{x^2-a^2}$	$\frac{1}{2a}\ln\frac{x-a}{x+a} + c$	$\lvert x\rvert > a > 0$
$\frac{1}{a^2-x^2}$	$\frac{1}{2a}\ln\frac{a+x}{a-x} + c$	$\lvert x\rvert < a$
$\frac{1}{\sqrt{x^2+a^2}}$	$\sinh^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{\sqrt{x^2-a^2}}$	$\cosh^{-1}\frac{x}{a} + c$	$x \geqslant a > 0$
$\frac{1}{\sqrt{x^2+k}}$	$\ln(x + \sqrt{x^2+k}) + c$	
$\frac{1}{\sqrt{a^2-x^2}}$	$\sin^{-1}\frac{x}{a} + c$	$-a \leqslant x \leqslant a$

$$Gravitational\ Acceleration = 9.8m/s^2$$

$$v = u + at$$

$$x - x_0 = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2a(x - x_0)$$

$$x - x_0 = \frac{1}{2}(u + v)t$$

$$F = ma$$

$$F_s = \mu_s n$$

$$F_k = \mu_k n$$

$$x = r\theta$$

$$v_{tan} = r\omega$$

$$a_{tan} = r\alpha$$

$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$$

$$F_c = \frac{mv^2}{r}$$

$$\rho = mv$$

$$I = m\Delta v$$

$$W = Force\ \times displacement$$

$$W = Fcos\theta\ \times displacement$$

$$E_{Kinetic} = \frac{1}{2}mv^2$$

$$E_{Potetial} = mgh$$

$$E_{spring} = \frac{1}{2}kx^2$$

$$W_{net} = \Delta E_{Kinetic}$$

$$W_{NC} = \Delta E_{Kinetic} + \Delta E_{Potential}$$

$$\Delta L = \alpha L \Delta T$$

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Faculty of Engineering & Technology

Department of Interdisciplinary Studies

BSc Hons (Eng) Mechanical/Automotive/Civil/Electronic/Mechatronic Engineering

Semester 2 - First Sit - Final Examination 2025

Module Code	:	**FE1321**
Module Title	:	**Engineering Mathematics II**
Date	:	**18th August 2025**
Examiner	:	**Shannon Wijeratne**
Time Allowed	:	**(01 00 pm – 4.00 pm)- 3 hours**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all four questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.

1.

a) Consider the following system of equations:

$$3x + 2y - z = 8$$

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

$$2x + y - 3z = 7$$

i) Find the ranks of the augmented matrix and the coefficient matrix using Gaussian elimination method. ***(30 marks)***

ii) Determine the nature of solutions for the above system and find the solutions if it exits. ***(7 marks)***

b) Consider the following matrix:

$$A = \begin{pmatrix} 2 & 2 & -2 \\ 1 & 3 & -1 \\ -1 & 1 & 1 \end{pmatrix}$$

i) Find the characteristic polynomial of the above matrix. ***(12 marks)***

ii) Find the eigenvalues of A. ***(9 marks)***

iii) Find the corresponding eigenvectors of A. ***(30 marks)***

iv) Find the normalized eigenvectors of A. ***(6 marks)***

v) Deduce the eigenvalues of $A - 3I$ and $2A$ using the eigenvalues of the matrix A in part ii), where I is the $3X3$ identity matrix. ***(6 marks)***

2.

a) Find the general/particular solution for each of the following differential equations using a **suitable method** and keep your answers in the **most simplified form**:

i) $\frac{1}{2y}\frac{dy}{dx} = (x^2+1)$ given $y = 1$ when $x = 1$ ***(12 marks)***

ii) $(2025 + 8x^2)\ \frac{dy}{dx} = 18x(1+y^2)$ ***(10 marks)***

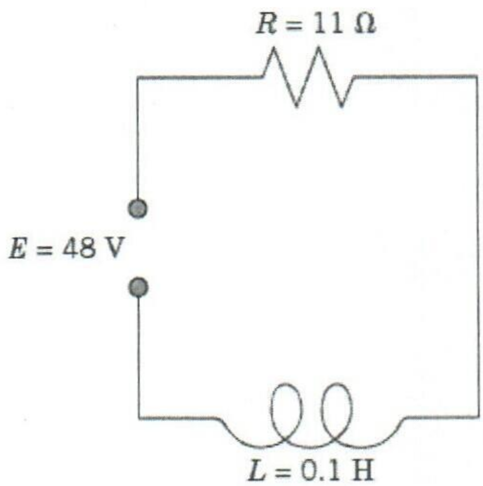
iii) $(cosx.sinx - xy^2)\ dx + y(1-x^2)dy = 0$ ***(18 marks)***

iv) $\frac{dy}{dx} - \frac{4y}{(x+1)} = 2(x+1)^3$ ***(15 marks)***

v) $\frac{dy}{dx} = 2e^{3x-2y}$ given $y = 0$ when $x = 0$ ***(15 marks)***

b) **Model** the *RL*-circuit in Figure 1 and **solve** the resulting ODE for the current $I(t)$ A (amperes), where *t* is time. Assume that the circuit contains as an EMF $E(t)$ (electromotive force) a battery of E=48 V (volts), which is constant, a resistor of R=11Ω(ohms) and an inductor of $L = 0.1\,H$ (Henry) and that the current is initially zero.

Physical Laws: A current *I* in the circuit causes a **voltage drop** *RI* across the resistor **(Ohm's law)** and a voltage drop $LI' = L\frac{dI}{dt}$ across the conductor, and the sum of these two voltage drops equals the EMF **(Kirchhoff's Voltage Law, KVL)**.



Circuit

(30 marks)

Figure 1

Figurc 1

3.

a) Show that the transformation T: $\mathbb{R}^2 \rightarrow \mathbb{R}^3$ is not a linear transformation, where

$$T\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} {x_1}^2 \\ 2x_1 \\ x_1x_2 \end{pmatrix}$$, using the vectors $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 5 \end{pmatrix}$

(12 marks)

b) Find the limit of each of the following sequences and state whether each is convergent or divergent:

i) $\lim\limits_{n\to\infty} \frac{3^{n+3}+2^{n-3}+5^{3n+1}}{4^{\frac{n}{2}}+5^{3n+1}+125}$ ***(12 marks)***

ii) $\lim\limits_{n\to\infty} \left(\frac{3n+3}{5n+2}\right)^n$ ***(12 marks)***

c) Determine whether each of the following series is convergent or divergent:

i) $\sum_{n=2}^{\infty} \frac{n^2}{n^4-1}$ using the limit comparison test. ***(12 marks)***

ii) $\sum_{n=0}^{\infty} \frac{1}{n^2+1}$ using the integral test. ***(10 marks)***

d) Determine the interval of convergence and the radius of convergence for the following power series:

$$\sum_{n=1}^{\infty} \frac{(x+5)^n}{n(n+1)}$$ ***(20 marks)***

e) Find the Maclaurin series for $\sin x$. ***(20 marks)***

4.

a) Consider the following set of vectors:

$$S = \left\{ \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \begin{pmatrix} 2 \\ 3 \\ 4 \end{pmatrix}, \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \\ 1 \end{pmatrix} \right\}$$

i) Find three linearly independent vectors from the set S. **(30 marks)**

ii) Find a basis for the space spanned by the above vectors and find whether they are orthogonal. **(10 marks)**

b) Determine the value of α, if V_1= (2,-4,5), V_2= (3,2,-4) and V_3= (-1,- 6, α) do not span $\mathbb{R}^3$.

(20 marks)

c) Let A and B be the following bases for $\mathbb{R}^2$.

$$A = \left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 3 \\ 2 \end{pmatrix} \right\} \quad \text{and} \quad B = \left\{ \begin{pmatrix} 2 \\ -1 \end{pmatrix}, \begin{pmatrix} -1 \\ 1 \end{pmatrix} \right\}$$

i) Find the change of basis matrix $P_{B \to A}$ from B to A. **(20 marks)**

ii) Let $v = \begin{bmatrix} 2 \\ 5 \end{bmatrix}$ with respect to the basis B. Find the coordinates of v with respect to the basis A. **(20 marks)**

Additional information

Inverse of a matrix:

$$A^{-1} = \frac{adj(A)}{|A|}$$

Characteristic polynomial C (λ)

$$c(\lambda) = |\lambda \boldsymbol{I} - \boldsymbol{A}| = 0$$

The normalized form of eigenvector:

$$\hat{e} = \frac{\boldsymbol{e}}{|e|}$$

where

$$|e| = \sqrt{(e_1^2 + e_2^2 + \ldots + e_n^2)}$$

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Semester 2 - First Sit - Final Examination 2025

Module Code	:	**FE1321**
Module Title	:	**Engineering Mathematics II**
Date	:	**18th August 2025**
Examiner	:	**Shannon Wijeratne**
Time Allowed	:	**(01 00 pm – 4.00 pm)- 3 hours**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all four questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.

1.

a) Consider the following system of equations:

$$3x + 2y - z = 8$$

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

$$2x + y - 3z = 7$$

i) Find the ranks of the augmented matrix and the coefficient matrix using Gaussian elimination method. ***(30 marks)***

ii) Determine the nature of solutions for the above system and find the solutions if it exits. ***(7 marks)***

b) Consider the following matrix:

$$A = \begin{pmatrix} 2 & 2 & -2 \\ 1 & 3 & -1 \\ -1 & 1 & 1 \end{pmatrix}$$

i) Find the characteristic polynomial of the above matrix. ***(12 marks)***

ii) Find the eigenvalues of A. ***(9 marks)***

iii) Find the corresponding eigenvectors of A. ***(30 marks)***

iv) Find the normalized eigenvectors of A. ***(6 marks)***

v) Deduce the eigenvalues of A -3I and 2A using the eigenvalues of the matrix A in part ii), where I is the $3X3$ identity matrix. ***(6 marks)***

2.

a) Find the general/particular solution for each of the following differential equations using a **suitable method** and keep your answers in the **most simplified form**:

i) $\frac{1}{2y}\frac{dy}{dx} = (x^2+1)$ given $y = 1$ when $x = 1$ ***(12 marks)***

ii) $(2025+8x^2)\ \frac{dy}{dx} = 18x(1+y^2)$ ***(10 marks)***

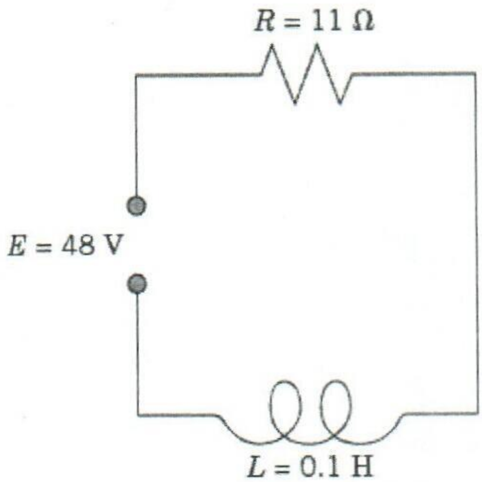
iii) $(cosx.sinx - xy^2)\ dx + y(1-x^2)dy = 0$ ***(18 marks)***

iv) $\frac{dy}{dx} - \frac{4y}{(x+1)} = 2(x+1)^3$ ***(15 marks)***

v) $\frac{dy}{dx} = 2e^{3x-2y}$ given $y = 0$ when $x = 0$ ***(15 marks)***

b) **Model** the *RL*-circuit in Figure 1 and **solve** the resulting ODE for the current $I(t)$ A (amperes), where *t* is time. Assume that the circuit contains as an EMF $E(t)$ (electromotive force) a battery of E=48 V (volts), which is constant, a resistor of R=11Ω(ohms) and an inductor of $L = 0.1\ H$ (Henry) and that the current is initially zero.

Physical Laws: A current *I* in the circuit causes a **voltage drop** *RI* across the resistor **(Ohm's law)** and a voltage drop $LI' = L\frac{dI}{dt}$ across the conductor, and the sum of these two voltage drops equals the EMF **(Kirchhoff's Voltage Law, KVL)**.



Circuit

(30 marks)

Figure 1

Figure 1

3.

a) Show that the transformation T: $\mathbb{R}^2 \rightarrow \mathbb{R}^3$ is not a linear transformation, where

$$T\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} {x_1}^2 \\ 2x_1 \\ x_1x_2 \end{pmatrix}$$, using the vectors $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 5 \end{pmatrix}$ ***(12 marks)***

b) Find the limit of each of the following sequences and state whether each is convergent or divergent:

i) $\lim\limits_{n\to\infty} \frac{3^{n+3}+2^{n-3}+5^{3n+1}}{4^{\frac{n}{2}}+5^{3n+1}+125}$ ***(12 marks)***

ii) $\lim\limits_{n\to\infty} \left(\frac{3n+3}{5n+2}\right)^n$ ***(12 marks)***

c) Determine whether each of the following series is convergent or divergent:

i) $\sum_{n=2}^{\infty} \frac{n^2}{n^4-1}$ using the limit comparison test. ***(12 marks)***

ii) $\sum_{n=0}^{\infty} \frac{1}{n^2+1}$ using the integral test. ***(10 marks)***

d) Determine the interval of convergence and the radius of convergence for the following power series:

$\sum_{n=1}^{\infty} \frac{(x+5)^n}{n(n+1)}$ ***(20 marks)***

e) Find the Maclaurin series for $\sin x$. ***(20 marks)***

4.

a) Consider the following set of vectors:

$$S = \left\{ \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \begin{pmatrix} 2 \\ 3 \\ 4 \end{pmatrix}, \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \\ 1 \end{pmatrix} \right\}$$

i) Find three linearly independent vectors from the set S. **(30 marks)**

ii) Find a basis for the space spanned by the above vectors and find whether they are orthogonal. **(10 marks)**

b) Determine the value of α, if V_1= (2,-4,5), V_2= (3,2,-4) and V_3= (-1,- 6, α) do not span $\mathbb{R}^3$.

(20 marks)

c) Let A and B be the following bases for $\mathbb{R}^2$.

$$A = \left\{ \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 3 \\ 2 \end{pmatrix} \right\} \quad \text{and} \quad B = \left\{ \begin{pmatrix} 2 \\ -1 \end{pmatrix}, \begin{pmatrix} -1 \\ 1 \end{pmatrix} \right\}$$

i) Find the change of basis matrix $P_{B \to A}$ from B to A. **(20 marks)**

ii) Let $v = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$ with respect to the basis B. Find the coordinates of v with respect to the basis A. **(20 marks)**

Additional information

Inverse of a matrix:

$$A^{-1} = \frac{adj(A)}{|A|}$$

Characteristic polynomial C (λ)

$$c(\lambda) = |\lambda \boldsymbol{I} - \boldsymbol{A}| = 0$$

The normalized form of eigenvector:

$$\hat{e} = \frac{e}{|e|}$$

where

$$|e| = \sqrt{(e_1^2 + e_2^2 + \ldots + e_n^2)}$$

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STEM Foundation

Semester 2 -In class Test 3

Module Code	:	**STEM 1511**
Module Title	:	**Foundation Mathematics II**
Date	:	**14th July 2026**
Examiners	:	**Ms. Hiruni Wickramasinghe**
Time Allowed	:	**(1.30 pm – 3.30 pm)- 2 hrs.**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of **five (05) questions**. Answer all questions.
- Use only the provided answer sheets for your answers.
- **Additional Information is provided on page 3**
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.

1. Evaluate each of the following indefinite integrals, giving the answers in exact form,

   a) $\int(5x^4 - 3x^2 + 6)dx$

   b) $\int(4e^{2x} - 7e^{-x})dx$

   c) $\int (6cosx - 2sinx)dx$

   d) $\int\left(\frac{5}{x} + \frac{2}{x^2}\right) dx$

   e) $\int(x^2 + 1)^2\, dx$ **(20 marks)**

2. Evaluate the following definite integrals,

   a) $\int_{-1}^{4}(24x^2 + 5x^4)dx$

   b) $\int_{0}^{\frac{\pi}{2}}\left(\frac{8}{\sqrt{x}} - 12x^{\frac{3}{2}}\right) dx$

   c) $\int_{0}^{4}(7sint - 2cost)dt$

   d) $\int_{-1}^{2}(1 + 3t)t^2dt$ **(20 marks)**

3. Evaluate the following integrals, by using substitution method,

   a) $\int x^2(x^3 + 2)^8dx$ **(8 marks)**

   b) $\int_{\pi}^{0} sinz\ \ cos^3z\ dz$ **(12 marks)**

4. Evaluate the following integrals, by using integration by parts method,

   a) $\int xe^x dx$ **(8 marks)**

   b) $\int_{0}^{\frac{\pi}{3}} 6x\ sin3x\ dx$ **(12 marks)**

5. Using partial fractions, Find the each of the following integrals.

   a) $\int_{0}^{2} \frac{x-5}{x^2+5x+4} dx$ **(8 marks)**

   b) $\int_{1}^{3} \frac{8x}{4x-3} dx$ **(12 marks)**

Additional Information

Integration

$f(x)$	$\int f(x)\,\mathrm{d}x$	
k, any constant	$kx + c$	
x	$\frac{x^2}{2} + c$	
x^2	$\frac{x^3}{3} + c$	
x^n	$\frac{x^{n+1}}{n+1} + c$	$n \neq -1$
$x^{-1} = \frac{1}{x}$	$\ln\lvert x\rvert + c$	
e^x	$\mathrm{e}^x + c$	
e^{kx}	$\frac{1}{k}\mathrm{e}^{kx} + c$	
$\cos x$	$\sin x + c$	
$\cos kx$	$\frac{1}{k}\sin kx + c$	
$\sin x$	$-\cos x + c$	
$\sin kx$	$-\frac{1}{k}\cos kx + c$	
$\tan x$	$\ln(\sec x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\sec x$	$\ln(\sec x + \tan x) + c$	$-\frac{\pi}{2} < x < \frac{\pi}{2}$
$\operatorname{cosec} x$	$\ln(\operatorname{cosec} x - \cot x) + c$	$0 < x < \pi$
$\cot x$	$\ln(\sin x) + c$	$0 < x < \pi$
$\cosh x$	$\sinh x + c$	
$\sinh x$	$\cosh x + c$	
$\tanh x$	$\ln\cosh x + c$	
$\coth x$	$\ln\sinh x + c$	$x > 0$
$\frac{1}{x^2+a^2}$	$\frac{1}{a}\tan^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{x^2-a^2}$	$\frac{1}{2a}\ln\frac{x-a}{x+a} + c$	$\lvert x\rvert > a > 0$
$\frac{1}{a^2-x^2}$	$\frac{1}{2a}\ln\frac{a+x}{a-x} + c$	$\lvert x\rvert < a$
$\frac{1}{\sqrt{x^2+a^2}}$	$\sinh^{-1}\frac{x}{a} + c$	$a > 0$
$\frac{1}{\sqrt{x^2-a^2}}$	$\cosh^{-1}\frac{x}{a} + c$	$x \geqslant a > 0$
$\frac{1}{\sqrt{x^2+k}}$	$\ln(x + \sqrt{x^2+k}) + c$	
$\frac{1}{\sqrt{a^2-x^2}}$	$\sin^{-1}\frac{x}{a} + c$	$-a \leqslant x \leqslant a$

Integration by parts: $\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$

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Faculty of Engineering & Technology **Department of Interdisciplinary Studies** **BSc. Hons. (Eng.) in Automotive/Mechanical/Electronic/Mechatronic/Civil Engineering** **Semester 2 Final - Examination 2026** **Batch : 8**	
Module Code: FE1311	**Module Title: Engineering Mathematics I**
Date: 13.07.2026	**Duration: 3 hours**
Examiner :	**Ms.Shannon Wijeratne**

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all four questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
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- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.

1. i) Find the following limits.

a) $\lim_{x \to 0} \frac{\sin x - x\cos x}{x^3}$ [12]

b) $\lim_{x \to 0} \frac{\ln(1+x)}{x}$ [8]

c) $\lim_{x \to 1} \frac{x^2+3x-4}{x^2-7x+6}$ [10]

ii) a) Use Cramer's rule to solve for x_1, x_2 and x_3.

$$2x_1 + x_2 - x_3 = 5$$
$$x_1 - x_2 + 2x_3 = 3$$
$$3x_1 + 2x_2 + x_3 = 10$$

[30]

b) Calculate the inverse of the following matrix A by the Gauss-Jordan elimination or state that it does not exist (Show the details of your work).

$$\begin{pmatrix} 2 & -1 & 0 \\ 3 & 5 & 4 \\ -1 & 1 & 0 \end{pmatrix}$$

[40]

2. i) Consider the following equation:

$$\left|\frac{Z-j}{Z-1-2j}\right| = \sqrt{2}$$

Show that the locus is a circle with the center at (2,3) and the radius 2 units. sketch the circle.

[45]

ii) Express $(1-\sqrt{3}i)$ in polar form and in exponential form, and find $(1-\sqrt{3}i)^{12}$. [20]

iii) Find an expression for cos3θ in terms of cosθ, using binomial theorem and De Moivre's theorem. [35]

3) i) If $f(x,y) = x^2y + 2xy^3 + x^3y^2$ find all first and second partial derivatives of $f(x,y)$. (i.e f_x , f_y , f_{xx} , f_{yy} , f_{xy} , f_{yx}).

[20]

ii) An equation for heat generated is given by $H = i^2Rt$. Determine the error in the calculated value if the error in measuring current i is +2%, the error in measuring resistance R is -3% and error in measuring time t is +1%.

[30]

iii) a) A running track is shaped like an ellipse. The length of the semi major axis is 75 meters, and semi minor axis is 40 meters .If the major axis is horizontal and the center is at its origin, find the equation of the ellipse (in standard form). Sketch the ellipse.

[20]

b)The maximum and minimum distances of the Earth from the Sun respectively are 149×10^6 km and 91.4×10^6 km. The Sun is at one focus of the elliptical orbit. Find the distance from the Sun to the other focus and sketch the positions of sun and earth on the ellipse.

[30]

4. i) For vectors $\boldsymbol{a}$ = [5, 2,-1] and $\boldsymbol{b}$ = [4,3, -1]

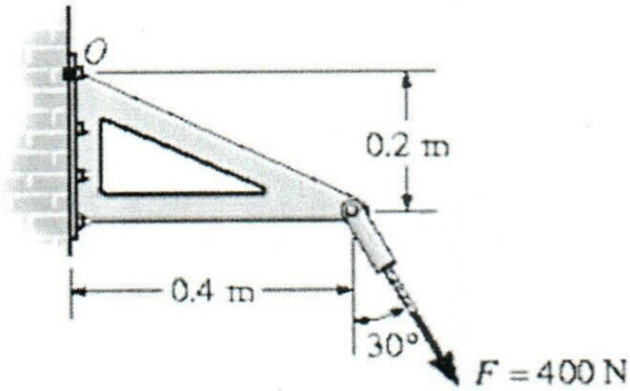
   a) Find $\boldsymbol{a} \times \boldsymbol{b}$
   b) Find the angle between $\boldsymbol{a}$ and $\boldsymbol{b}$.

[18]

ii) Let $\boldsymbol{a} = 3\boldsymbol{i} + \boldsymbol{j} + \boldsymbol{2k}$ and $\boldsymbol{b} = \boldsymbol{2i} - 4\boldsymbol{j} + 3\boldsymbol{k}$.

If a parallelogram is formed by vectors $\boldsymbol{a}$ and $\boldsymbol{b}$, find the area of the parallelogram. [10]

iii) Find the moment of the force F about the point O.



[10]

iv) Evaluate the following integrals using a suitable method.

a) $\int 2\sqrt{1-x^2}\ dx$ [16]

b) $\int e^x \cos x\, dx$ [15]

c) $\int sec^4 x\ tan^3\ xdx$ [16]

d) $\int \frac{x^2+4}{3x^3+4x^2-4x} dx$ [15]

Additional Information

Partial Derivatives:

1 *Small increments* ***(Total differentials of z)***

$$z = f(x,y) \quad \delta z = \frac{\partial z}{\partial x}\delta x + \frac{\partial z}{\partial y}\delta y \qquad \text{(a)}$$

2 *Rates of change* ***(Simple Chain Rule)***

$$\frac{dz}{dt} = \frac{\partial z}{\partial x}.\frac{dx}{dt} + \frac{\partial z}{\partial y}.\frac{dy}{dt} \qquad \text{(b)}$$

3 *Implicit functions*

$$\frac{dz}{dx} = \frac{\partial z}{\partial x} + \frac{\partial z}{\partial y}.\frac{dy}{dx} \qquad \text{(c)}$$

4 *Change of variables* ***(Chain Rule for Two Sets of Independent Variables,***

$$\frac{\partial z}{\partial u} = \frac{\partial z}{\partial x}.\frac{\partial x}{\partial u} + \frac{\partial z}{\partial y}.\frac{\partial y}{\partial u}$$
$$\frac{\partial z}{\partial v} = \frac{\partial z}{\partial x}.\frac{\partial x}{\partial v} + \frac{\partial z}{\partial y}.\frac{\partial y}{\partial v} \qquad \text{(d)}$$

Standard derivatives:

F(x)	$\frac{df(x)}{dx}$
x^n	nx^{n-1}
$\sin ax$	$a\cos ax$
$\cos ax$	$-a\sin ax$
$\tan ax$	$asec^2ax$
$\sec ax$	$a\sec ax\,.\,tanax$
e^{ax}	ae^{ax}
$\ln ax$	$\frac{a}{x}$

Standard Integrals:

$f(x)$	$\int f(x)dx$
x^n	$\frac{x^{n+1}}{n+1}$, for $n \neq 1$
e^x	e^x
e^{ax}	$\frac{1}{a}e^{ax}$
$\frac{1}{x}$	$\ln x$
$\sin ax$	$-\frac{1}{a}\cos ax$
$\cos ax$	$\frac{1}{a}\sin ax$

Rules of differentiation	$\frac{d}{dx}(uv) = u\frac{dv}{dx} + v\frac{du}{dx}$ $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$ $\frac{dy}{dx} = \frac{dy}{du}\frac{du}{dx}$
Integration by parts equation	$\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$

Radius of Curvature:

$$R = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}{\left|\frac{d^2y}{dx^2}\right|}$$

TRIGONOMETRIC IDENTITIES

RECIPROCAL IDENTITIES

$$\cot x = \frac{1}{\tan x} = \frac{\cos x}{\sin x}$$

$$\csc x = \frac{1}{\sin x}$$

$$\sec x = \frac{1}{\cos x}$$

PYTHAGOREAN IDENTITIES

$$\boxed{\sin^2 x + \cos^2 x = 1}$$

$$\sin^2 x = 1 - \cos^2 x$$

$$\cos^2 x = 1 - \sin^2 x$$

$$1 + \tan^2 x = \sec^2 x$$

$$1 + \cot^2 x = \csc^2 x$$

SUM AND DIFFERENCE IDENTITIES

$$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y$$

$$\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y$$

$$\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}$$

DOUBLE-ANGLE IDENTITIES

$$\sin 2x = 2 \sin x \cos x = \frac{2 \tan x}{1 + \tan^2 x}$$

$$\cos 2x = \cos^2 x - \sin^2 x$$

$$= 2\cos^2 x - 1$$

$$= 1 - 2\sin^2 x = \frac{1 - \tan^2 x}{1 + \tan^2 x}$$

$$\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}$$

$$\cot 2x = \frac{\cot^2 x - 1}{2 \cot x}$$

HALF-ANGLE IDENTITIES

$$\sin\frac{x}{2} = \pm\sqrt{\frac{1 - \cos x}{2}}$$

$$\cos\frac{x}{2} = \pm\sqrt{\frac{1 + \cos x}{2}}$$

$$\tan\frac{x}{2} = \pm\sqrt{\frac{1 - \cos x}{1 + \cos x}} = \frac{\sin x}{1 + \cos x} = \frac{1 - \cos x}{\sin x}$$

Binomial Theorem:

$$(a + b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k$$

De Moivre's Theorem:

$$z^n = r^n(\cos n\theta + i \sin n\theta)$$