071306T4EEN

ELECTRICAL ENGINEERING (POWER OPTION) LEVEL 6

ENG/OS/PO/CC/01/6

APPLY ENGINEERING MATHEMATICS

July/August 2024

Time: 3 Hours

TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL (TVET CDACC)

WRITTEN ASSESSMENT

3 HOURS

INSTRUCTIONS TO CANDIDATE

1. This paper consists of **TWO** sections **A** and **B**.
2. Answer **ALL** questions in section **A** and **THREE** questions in section **B** in the booklet provided.
3. Marks for each question are indicated in the brackets.
4. Do not write on this question paper.
5. Answer the questions in **English**

This paper consists of FIVE (5) printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A (40 marks)

*Attempt **ALL** questions in this section.*

1. A constant force of $\boldsymbol{F = 10i + 2j - k}$ Newton displaces an object from $\mathbf{A = i + j + k}$ to $\mathbf{B = 2i - j + 3k}$ (in metres). Find the work done in Newton metres [4 marks]
2. Determine the modulus and argument of the complex number$\boldsymbol{Z = 2 + j3}$, and express *Z* in polar form [4 marks]
3. Calculate the volume and the total surface area of a hemisphere of diameter 15.0 cm. [3 marks]
4. Find the inverse Laplace transform of $\frac{\boldsymbol{s}}{\boldsymbol{s^2+5s+6}}$. [4 marks]
5. Solve the equation $\boldsymbol{\log(x^2 - 3) - logx = log2}$. [4 marks]
6. Solve the following simultaneous equations using crammers rule. [5 marks]

   $\boldsymbol{x + y + z = 4}$

   $\boldsymbol{2x - 3y + 4z = 33}$

   $\boldsymbol{3x - 2y - 2z = 2}$
7. Prove that $\boldsymbol{cot\,2\,x + cosec\,2x = cot\,x}$. [4 marks]
8. Find the rate of change of *y* with respect to *x* given that $\boldsymbol{y = 3\sqrt{x}\,ln2x}$. [4 marks]
9. The major axis of an ellipse is 15.0 cm and the minor axis is 9.0 cm. Find the area and perimeter of the ellipse. [4 marks]
10. A bag contains 8 green balls and 5 red balls. Find the probability of obtaining two balls of the same colour. [4 marks]

SECTION B (60 marks)

*Answer any **three** questions in this section*

11. a) solve the differential equation by the D Operator Method;

$$\frac{d^2q}{dt^2} - 4\frac{dq}{dt} + 3q = e^{2t}sin3t.$$ [10 Marks]

b) Determine the Fourier sine series of the function

$$f(x) = \begin{cases} -2, & when -\pi < x < 0 \\ 2, & when \quad 0 < x < 0 \end{cases}$$ [10 Marks]

12. Determine the mean and the standard deviation from the grouped data in table 1. [10marks]

Table 1

Mass (Kg)	20-22	23-25	26-28	29-31	32-34
No. of students	5	18	42	27	8

b) Given the magnetic field vector $A = x^2yz + xz^2$ and $B = xy^2z - z^3$ determine at the Point (2, 1, 3) $\nabla(AB)$. [10 Marks]

13. a) Using Laplace transforms technique solve the following initial value problem

$$\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 6y = 5sint \qquad \frac{dy}{dx}(0) = 0, y(0) = 0$$ [12marks]

b) Determine the area bounded by the curve $y = x^2 + x + 1$ and the coordinates

$x = 0\ and\ x = 1$ [8marks]

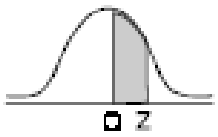
14. a) Use Newton-Raphson formula to determine a better approximate to the root of the equation

$\{x^2 = 3x)$. [9marks]

b) Find the tipple cross product given vectors $a = -3i + 7j + 5k, b = -3i + 7j - 3k\ and\ c = 7i - 5j - 3j.$ [11marks]

Table

Area under standard normal curve from 0 to $\frac{x-\mu}{\sigma}$



$\frac{x-\mu}{\sigma}$	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0159	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1084	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2611	.2642	.2671	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.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	.4232	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4430	.4441
1.6	.4452	.4463	.4474	.4485	.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	.4762	.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	.4990
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	.4945	.4946	.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	.4980	.4980	.4981
2.9	.4981	.4982	.4983	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.49865	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.49903	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993

TABLE OF LAPLACE TRANSFORMS

FUNCTION $F(t)$	TRANSFORM $F(s) = \int_0^\infty e^{-st}F(t)dt$
1. 1	$1/s$
2. e^{at}	$\frac{1}{s-a}$
3. $\cos at$	$\frac{s}{s^2+a^2}$
4. $\sin at$	$\frac{a}{s^2+a^2}$
5. t	$\frac{1}{s^2}$
6. t^n	$\frac{n!}{s^{n+1}}$
7. $\cosh at$	$\frac{s}{s^2-a^2}$
8. $\sinh at$	$\frac{a}{s^2-a^2}$
9. $t\cos at$	$\frac{s^2-a^2}{(s^2+a^2)^2}$
10. $t\sin at$	$\frac{2as}{(s^2+a^2)^2}$
11. $e^{-at}t^n$	$\frac{n!}{(s+a)^{n+1}}$
12. $e^{-at}\cos bt$	$\frac{s+a}{(s^2+a^2)^2+b^2}$
13. $e^{-at}\sin bt$	$\frac{b}{(s^2+a^2)^2+b^2}$
14. $e^{-at}\cosh bt$	$\frac{s+a}{(s^2+a^2)^2-b^2}$
15. $e^{-at}\sinh bt$	$\frac{b}{(s^2+a^2)^2-b^2}$

Some theorems used in Laplace Transforms.

1. $if\ F(s) = L\{F(t)\}, then\ F(s+a) = L\{e^{-at}F(t)\}$
2. $L\left\{\frac{dx}{dt}\right\} = sL\{x\} - x(0)\ \ and\ L\left\{\frac{d^2x}{dt^2}\right\} = s^2L\{x\} - sLx(0) - x'(0)$

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