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TEACHERS' RESOURCE UNIT TRU-RIP-STA MOCK EXAMS NORTH WEST REGION

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MARCH 2021

The Teachers' Resource Unit and the Regional Inspectorate of Pedagogy in collaboration with MTA	SUBJECT CODE NUMBER **0775**	PAPER NUMBER **2**
GENERAL CERTIFICATE OF EDUCATION REGIONAL MOCK EXAMINATION	SUBJECT TITLE **FURTHER MATHEMATICS**	
ADVANCED LEVEL		

Time Allowed: THREE hours

INSTRUCTIONS TO CANDIDATES

Mobile phones are **NOT ALLOWED** in the examination room.

Answer ALL TEN questions

For your guidance, the appropriate mark for each part of a question is indicated in brackets.

You will be marked on your ability to use good English, to organize information clearly and to use specialist vocabulary where appropriate.

In calculations, you are advised to show all the steps in your working, giving your answer at each stage.

You are reminded of the necessity for good English and orderly presentation in your answers.

TURN OVER

1. Solve the differential equation

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 13y = e^{2x}$$

for which $y = \frac{dy}{dx} = 1$ when $x = 0$. 7 marks

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2. The points A, B and C have coordinates $(-1,1,2)$, $(2,3,3)$ and $(-1,-3,0)$ respectively, referred to the Cartesian frame $Oxyz$.

Find

i) the area of triangle ABC. 3 marks

ii) the Cartesian equation of the plane ABC. 4 marks

iii) the distance of the point $D(-3,-2,5)$ from the plane ABC. 2 marks

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3. a) Show that the length of the arc of the curve $y = f(x)$ where

$$f(x) = \ln \sec x, \qquad 0 \le x < \frac{\pi}{4} \text{ is}$$

$$\ln\left(1+\sqrt{2}\right).$$

4 marks

b) Given that

$$I_{m,n} = \int_0^1 \left(1 - x^m\right)^n dx, \qquad m, n \in \mathbb{Z}^+$$

prove that

$$(mn+1)I_{m,n} = I_{m,n-1}.$$

4 marks

Evaluate

$$I_{2,4}.$$

2 marks

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4. Find d, the

$$\gcd(2695, 1547).$$

3 marks

Hence or otherwise, express in the form

$$2695p + 1547q = d, \;\; p, q \in \mathbb{Z}.$$

5 marks

Solve for x,

$$54x \equiv 7 (\text{mod } 31).$$

2 marks

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5. Solve completely the complex equation,

$$z^4 - 1 = 0.$$

2 marks

The solution set S, of the equation $z^4 = 1$ is a Group under multiplication of complex numbers.

i) State the identity element of this group. 1 mark

ii) Find the inverse of each element. 2 marks

The set $T = \{3, 6, 9, 12\}$ under multiplication modulo 15 also forms a Group.

iii) Find the identity element, and the inverse of each element. 3 marks

iv) Establish an isomorphism $S \cong T$. 2 marks

6. Given the matrices M and N where

$$M = \begin{pmatrix} 2 & 1 & 4 \\ 3 & 5 & 1 \\ 1 & 2 & 0 \end{pmatrix}, \qquad N = \begin{pmatrix} -2 & 8 & -19 \\ 1 & -4 & 10 \\ 1 & -3 & 7 \end{pmatrix}.$$

Find

i) MN — 2 marks

ii) the plane whose image under M is $x - 3y + 6z = -4$ — 2 marks

iii) the vector equation of the line whose image under M is

$$\mathbf{r} = (\mathbf{i} - 2\mathbf{j} - \mathbf{k}) + \lambda(7\mathbf{i} + 9\mathbf{j} + 3\mathbf{k}).$$ 2 marks

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7. Prove that

$$\tanh^{-1} x = \tfrac{1}{2}\ln\left(\frac{1+x}{1-x}\right), -1 < x < 1.$$ 3 marks

Hence or otherwise

i) show that

$$\int e^{2\tanh^{-1} x} dx = k - \left[x + 2\ln(1-x)\right] \text{ where } k \text{ is a constant.}$$ 3 marks

ii) solve for x,

$$\tanh^{-1}\left(\frac{2x}{1+x^2}\right) = \ln 2.$$ 2 marks

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8. a) A similarity transformation is defined by

$$z^* = 2iz + 1 - i.$$

Find

i) the invariant point of the transformation. — 2 marks

ii) the scale factor and the angle of rotation of the transformation. — 1 mark

On an Argand plane,

iii) draw an arbitrary square and its image under the transformation. — 2 marks

b) Find the points of intersection (r, θ) of the polar curves

$$r = 1 + 3\cos\theta \text{ and } r = \frac{2}{2 - \cos\theta}.$$ 3 marks

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9. Two recursive sequences u_n and v_n are defined by

$$u_0 = 9,\ u_{n+1} = \tfrac{1}{2}u_n - 3.$$
$$v_n = u_n + 6.$$

i) Show that v_n is a geometric sequence with common ratio $r = \frac{1}{2}$ and $v_0 = 15$. — 4 marks

ii) Calculate

$$S_n = \sum_{k=0}^{n} v_k \text{ in terms of } n.$$ 4 marks

iii) Hence or otherwise find

$$T_n = \sum_{k=0}^{n} u_k \text{ in terms of } n.$$ 1 mark

iv) Evaluate $\lim_{n\to\infty} S_n$ and $\lim_{n\to\infty} T_n$. — 2 marks

Another sequence w_n is defined by

$$w_n = \ln(v_n).$$

v) Show that w_n is an arithmetic sequence with common difference $-\ln 2$. 2 marks

vi) Calculate

$$T_n = \sum_{k=0}^{\infty} w_k .$$ 2 marks

10. Given the function f, where

$$f(x) = \ln\left(\frac{x+3}{x-1}\right)$$

i) Find the domain of definition of f. 2 marks

ii) Show that f is injective. 2 marks

ii) Find the limit of f at the boundaries of its domain. 3 marks

iii) Find the equations of the three asymptotes to the curve $y = f(x)$. 3 marks

iv) Investigate the variation of f and draw its variation table. 2 marks

v) Sketch the curve $y = f(x)$. 2 marks

vi) State the centre of symmetry of the curve $y = f(x)$. 1 mark

END