

UNIVERSITY OF BOLTON

**SCHOOL OF THE BUILT ENVIRONMENT &
ENGINEERING**

BSc(HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2009/2010

MATHEMATICS B

MODULE NO: BLT1010

Date: Wednesday 2 June 2010

Time: 10.00 am – 12.00 noon

INSTRUCTIONS TO CANDIDATES:

There are **FOUR** questions.

Answer **THREE** questions.

This examination paper carries a total of 60 marks.

All questions carry equal marks.

A formula sheet is provided.

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1. (a) Evaluate the following indefinite integrals using integration by parts:

(i) $\int 6x \cos 3x dx$

(ii) $\int x^2 \ln 4x dx$

(iii) $\int x^2 e^{3x} dx$ (12 marks)

(b) Estimate the following definite integral using:

(i) the trapezoidal rule with four strips,

(ii) Simpson's rule with four strips.

$$\int_0^{2\pi/3} \sin \theta d\theta$$

Calculate and comment on the percentage errors in your results.

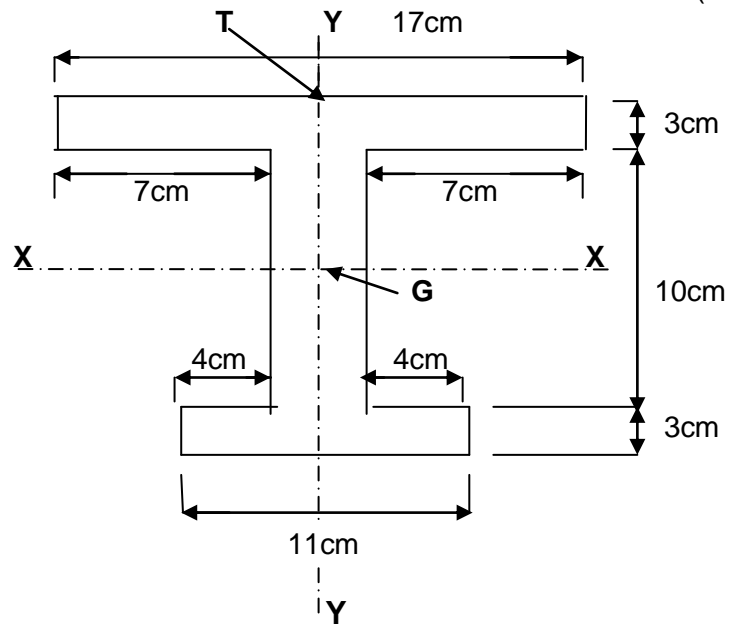
(8 marks)

Total 20 marks

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2. (a) Calculate the distance from the centroid of the Cross Section **G** to the top of the section at **T**. (5 marks)
- (b) Calculate the Second Moment of Area for this Cross Section
 (i) about **X - X** (10 marks)
 (ii) about **Y - Y**. (5 marks)



Total 20 marks

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3. (a) For the matrices

$$A = \begin{pmatrix} 6 & 5 & -9 \\ 8 & 1 & 0 \\ -3 & 7 & -3 \end{pmatrix} \quad B = \begin{pmatrix} 3 & 1 & 2 \\ 6 & 0 & -4 \\ 9 & -5 & 4 \end{pmatrix}$$

calculate the following:

(i) $A + B$ (ii) AB (iii) BA

Comment on your answers to (ii) and (iii) (10 marks)

(b) Using matrices, solve the following system of linear simultaneous equations:

$$\begin{aligned} 2x_1 - x_2 + 3x_3 &= 8 \\ x_1 + 3x_2 - x_3 &= -2 \\ 2x_1 - 2x_2 + 5x_3 &= 11 \end{aligned} \quad (10 \text{ marks})$$

Total 20 marks

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4. The following table of data gives the amount spent £ X on regular maintenance per £1000 value of construction plant, and the cost in lost production £ Y due to breakdown per £1000 value of construction plant used, for each of ten civil engineering contracting companies for the year 2008:

X	70	72	78	85	95	109	118	130	150	170
Y	225	230	205	225	202	190	210	204	180	190

- (i) by drawing up an appropriate table, find the totals ΣX , ΣY , ΣX^2 , ΣY^2 and ΣXY .
 (5 marks)
- (ii) draw a scatter diagram for the data
 (5 marks)
- (iii) calculate the correlation coefficient r , and comment on its value
 (5 marks)
- (iv) determine the regression equation of Y on X and indicate the line of best fit on your scatter diagram.
 (5 marks)

Total 20 marks

END OF QUESTIONS

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FORMULA SHEET

1. Quadratic Equations

For the equation $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

2. Laws of Logarithms

$$\log AB = \log A + \log B$$

$$\log \frac{A}{B} = \log A - \log B$$

$$\log A^p = p \log A$$

3. Matrices

For the square matrix A

$$A^{-1} = \frac{\text{Adj}A}{|A|}$$

4. Simpson's Rule

$$\text{Area} = \frac{h}{3} \{(y_1 + y_n) + 4(y_2 + y_4 + \dots + y_{n-1}) + 2(y_3 + y_5 + \dots + y_{n-2})\}$$

5. Trapezium Rule

$$\text{Area} = h \left\{ \frac{y_0 + y_n}{2} + (y_1 + y_2 + y_3 + \dots + y_{n-1}) \right\}$$

6. Statistics

$$\text{Relative frequency} = \frac{f}{\sum f}$$

$$\text{Mean : } \bar{x} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation : } s = \sqrt{\frac{\sum fx^2}{\sum f} - (\bar{x})^2}$$

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Least squares regression :

$$\begin{aligned} \sum y &= m \sum x + Nc \\ \text{the normal equations are :} \quad \sum xy &= m \sum x^2 + c \sum x \end{aligned}$$

$$\text{Correlation coefficient :} \quad r = \frac{N \sum xy - \sum x \sum y}{\sqrt{[N \sum x^2 - (\sum x)^2][N \sum y^2 - (\sum y)^2]}}$$

7. Calculus

$$\text{If } y = u.v \text{ then } \frac{dy}{dx} = v \frac{du}{dx} + u \frac{dv}{dx}$$

$$\text{If } y = \frac{u}{v} \text{ then } \frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$\text{If } y \text{ is a function of } u \text{ and } u \text{ is a function of } x \text{ then } \frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$$

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

8. Small Increments

$$\text{If } w = f(x, y, z) \text{ then } \delta w \approx \frac{\delta w}{\delta x} \delta x + \frac{\delta w}{\delta y} \delta y + \frac{\delta w}{\delta z} \delta z$$

9. Second Moment of Area

$$I = \frac{bd^3}{12} \quad I_{AA} = I_{XX} + As^2$$

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CALCULUS

(* the constant of integration has been omitted *)

$\int y dx$	y	$\frac{dy}{dx}$
$\left. \begin{array}{l} \frac{x^{n+1}}{n+1} \quad n \neq -1 \\ \ln x \quad n = -1 \end{array} \right\}$	x^n	nx^{n-1}
$x \ln x - x$	$\ln x$	$\frac{1}{x}$
$\frac{1}{a} e^{ax}$	e^{ax}	ae^{ax}
$\frac{a^x}{\ln a}$	$a^x \quad a > 0$	$a^x \ln a$
$\frac{(ax+b)^{n+1}}{a(n+1)} \quad n \neq -1$	$(ax+b)^n$	$na(ax+b)^{n-1}$
$\frac{1}{a} \ln(ax+b) \quad n = -1$		
$\ln f(x)$	$\frac{f'(x)}{f(x)}$	
$-\frac{1}{a} \cos ax$	$\sin ax$	$a \cos ax$
$\frac{1}{a} \sin ax$	$\cos ax$	$-a \sin ax$
$\frac{1}{a} \ln \sec ax $	$\tan ax$	$a \sec^2 ax$
$\frac{1}{a} \ln\left \tan \frac{ax}{2}\right $	$\operatorname{cosec} ax$	$-a \operatorname{cosec} ax \cot ax$
$\frac{1}{a} \ln \sec ax + \tan ax $	$\sec ax$	$a \sec ax \tan ax$
$\frac{1}{a} \ln \sin ax $	$\cot ax$	$-a \operatorname{cosec}^2 ax$
$\frac{1}{a} \cosh ax$	$\sinh ax$	$a \cosh ax$
$\frac{1}{a} \sinh ax$	$\cosh ax$	$a \sinh ax$

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$\int y dx$	y	$\frac{dy}{dx}$
$\frac{1}{a} \ln \cosh ax$	$\tanh ax$	$a \operatorname{sech}^2 ax$
$\sin^{-1} \left[\frac{x}{a} \right]$	$\frac{1}{\sqrt{a^2 - x^2}}$	
$\frac{1}{a} \tan^{-1} \left[\frac{x}{a} \right]$	$\frac{1}{x^2 + a^2}$	
$\sinh^{-1} \left[\frac{x}{a} \right]$	$\frac{1}{\sqrt{a^2 + x^2}}$	
$\cosh^{-1} \left[\frac{x}{a} \right]$	$\frac{1}{\sqrt{x^2 - a^2}}$	
$\cos^{-1} \left[\frac{x}{a} \right]$	$\frac{-1}{\sqrt{a^2 - x^2}}$	

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SIGNIFICANCE OF CORRELATION COEFFICIENT

If the value obtained is higher than that shown below, it is significant at the level indicated.

	Level of significance (%)					
	5	2.5	1	0.5	0.1	0.05
One tail	5	2.5	1	0.5	0.1	0.05
Two tail	10	5	2	1	0.2	0.1
Number of pairs of observations						
4	0.900	0.950	0.980	0.990	0.998	0.999
5	0.805	0.878	0.934	0.959	0.986	0.991
6	0.729	0.811	0.882	0.917	0.963	0.974
7	0.669	0.754	0.833	0.875	0.935	0.951
8	0.621	0.707	0.789	0.834	0.905	0.925
9	0.582	0.666	0.750	0.798	0.875	0.898
10	0.549	0.632	0.715	0.765	0.847	0.872
11	0.521	0.602	0.685	0.735	0.820	0.847
12	0.497	0.576	0.658	0.708	0.795	0.823
13	0.476	0.553	0.634	0.684	0.772	0.801
14	0.457	0.532	0.612	0.661	0.750	0.780
15	0.441	0.514	0.592	0.641	0.730	0.760
16	0.426	0.497	0.574	0.623	0.711	0.742
17	0.412	0.482	0.558	0.606	0.694	0.725
18	0.400	0.468	0.543	0.590	0.678	0.708
19	0.389	0.456	0.529	0.575	0.662	0.693
20	0.378	0.444	0.516	0.561	0.648	0.679

* ignoring sign