

**DUBLIN INSTITUTE OF TECHNOLOGY**

**First Year Engineering Entrance Examination 2018**

**In**

**MATHEMATICS**

**August 2018**

**Attempt ALL 5 QUESTIONS**

**Time Allowed: 3 hours**

**All questions carry equal marks**

**Maths Tables and graph paper are available for use**

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1. (a) Express  $z = (6 - 2i)(1 - 3i)$  in polar form and calculate  $z^4$ . Express the results both in polar and rectangular forms.

(b) Find  $a$  if  $z=3+i$  is a root of  $3z^2 + 3z + 3a - 17 + 12i = 0$ .

(c) Simplify the following expression involving indices:

$$\frac{x^5y^2x^3 + x^4y^5 - y^5x^7y^4}{x^2y^2}$$

(d) Expand the following binomial:  $(x - y)^5$

2. (a) A lot contains 17 items of which 7 are defective. Four items are drawn at random from the lot, without being replaced. Find the probability  $p$  that all four are non defective.

(b) In a survey 100 students were asked about their preference for foreign language subjects. It was found that 42 chose German, 39 chose French and 44 chose Spanish. It was also found that 17 chose German and French, 9 chose French and Spanish, 12 chose German and Spanish and 10 didn't choose any foreign language.

(i) Use a Venn diagram to show the number of students, their options and fill in the correct number of students in each of the regions of the diagram.

(ii) Find the number of students that chose only one foreign language.

(iii) Determine the number of students that chose 2 foreign languages.

(c) The mean height of a group of 100 people is 163cm with a standard deviation of 6cm. Assuming the heights are *normally* distributed find the probability of a person's height being:

- (i) less than 163cm
- (ii) more than 168cm
- (iii) greater than 179cm

3. (a) Make  $x$  the subject of the formula:  $y + 7xb = \frac{x}{6b} + x8b$

(b) Solve the simultaneous equations:

$$\begin{aligned} 3x + 2y + z &= 5 \\ x + 4y + 4z &= 4 \\ 2x + 3y + 2z &= 2 \end{aligned}$$

(c) Solve for  $x$ :

(i)  $\log_{10}(x + 2) + \log_{10}(x - 2) = 2$

(ii)  $\ln\left(\frac{x-2}{x-7}\right) = 4$

(d) In a chemical reaction, the amount of material in grams after  $t$  hours is given by

$$M = 70e^{0.3t}$$

(i) What is the initial amount of  $M$ ?

(ii) How much material is present after 10 hours and estimate how long it will take for  $M$  to reach 600 grams.

4. (a) Given the following :

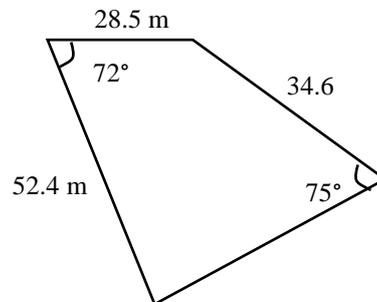
$$C_1 \text{ is the circle } x^2 + y^2 + 2x - 2y - 23 = 0$$

$$C_2 \text{ is the circle } x^2 + y^2 - 14x - 2y + 41 = 0$$

Prove that both circles touch externally and find the point of contact.

(b) Find the equation of the line that passes through the point of intersection of the lines  $3x + 2y - 1 = 0$  and  $2x - y + 7 = 0$  and is perpendicular to the line  $3y + 3x = 4$ .

(c) A building site is in the form of a quadrilateral as shown below. Determine the length of the perimeter of the site.



(d) Sketch the graphs of  $\sin(x)$  and  $\sin(2x)$  between 0 and  $2\pi$ . Hence solve the following equation  $\sin(2x) = 0.866025$  for  $0 \leq x \leq 360^\circ$ .

5. (a) Find values of the first derivatives of the following at the given points:
- (i)  $f(x) = (2x^2 + 16x - 4)^4$  at  $x =$
- (ii)  $g(x) = (13x^2 - 127x)(2e^x)$  at  $x = 0$
- (b) Given the function  $y = 3x^3 - 15x^2 - 42x + 12$ . Find the two turning points and specify if they are maximum or minimum points.
- (c) Determine the following integrals:
- (i)  $\int \left(2x^3 - 8x + 17x^{-1} - \frac{6}{x^3}\right) dx$
- (ii)  $\int 9e^x + \frac{16 + 3x^4 + 3x + 7}{x^2} dx$
- (d) Find the area under the curve  $y = 37x + 2x^2 + 3x - 4$  between the values  $x = 7$  and  $x = 1$ .

