

## MATH 1210 Tutorial 4

1. Find the remainder when the first polynomial is divided by the second:

(a)  $x^4 + (3 + i)x^3 - 2ix + 5$ ,  $x - 4i$       (b)  $x^3 - 2x^2 + 3x + 6$ ,  $3x + 2$

2. If  $3 - 2i$  is a zero of the polynomial

$$3x^3 - 17x^2 + 33x + 13,$$

what are its other zeros?

3. What are the values of  $h$  and  $k$  if the remainders are  $298/81$  and  $141$  when

$$4x^4 + hx^3 - 3x^2 + kx + 5$$

is divided by  $3x + 1$  and  $x - 2$ , respectively?

In each of the following questions: (a) use Descartes' rules of signs to state the number of possible positive and negative zeros of the polynomial; (b) use the bounds theorem to find bounds for zeros of the polynomial; (c) use the rational root theorem to list all possible rational zeros of the polynomial; (d) find all roots of the equation. Take the results of (a) and (b) into account in (c).

4.  $P(x) = 2x^4 - 13x^3 + 24x^2 - 9x$   
5.  $P(x) = 3x^4 - 10x^3 - 20x^2 - 23x - 10$   
6.  $P(x) = 12x^4 - 11x^3 + 50x^2 - 44x + 8$   
7.  $P(x) = 2x^5 - x^4 + 2x - 1$

### Answers:

- 1.(a)  $333 - 192i$     (b)  $\frac{76}{27}$   
2.  $3 + 2i, -1/3$   
3.  $h = 10, k = 2$   
4.(a) 3 or 1 positive, 0 negative (b)  $|x| < 13$  (c)  $1, 3, 9, 1/2, 3/2, 9/2$  (d)  $0, 1/2, 3$ (multiplicity 2)  
5.(a) 1 positive, 3 or 1 negative (b)  $|x| < 26/3$  (c)  $\pm 1, \pm 2, \pm 5, \pm 1/3, \pm 2/3, \pm 5/3, \pm 10/3$   
(d)  $-2/3, 5, -1/2 \pm \sqrt{3}i/2$   
6.(a) 4, 2, or 0 positive (b)  $|x| < 31/6$  (c)  $1, 2, 4, 1/2, 2/3, 4/3, 8/3, 1/4, 1/6, 1/12$  (d)  $1/4, 2/3, \pm 2i$   
7.(a) 3 or 1 positive, 0 negative (b)  $|x| < 2$  (c)  $1, 1/2$  (d)  $1/2, (1 \pm i)/\sqrt{2}, (-1 \pm i)/\sqrt{2}$