

# MSF Graduate Programme

## Sample Entrance Exam Problems

For students who have not majored in Mathematics

This list of problems is meant to give you an approximate idea of the kinds of questions we may ask. It is not comprehensive.

Note that the exam is followed by an interview – what really matters is how you respond to our queries in it. Students who did not do very well in the written test have still been selected if they have picked up our hints and suggestions and corrected their answers during the interview.

1. If  $A$  and  $B$  are two non-zero square matrices of order  $n$  such that  $A^2B = I$  then
  - (a)  $A$  is invertible but  $B$  may or may not be invertible
  - (b)  $A$  and  $B$  both are invertible
  - (c)  $A^2$  is invertible but  $A$  and  $B$  may not be invertible
  - (d) none of the above
2.  $P(z)$  and  $Q(z)$  are two polynomials, each of degree 3, such that  $P(z) = Q(z)$  for  $z = 0, 1, 2$  and  $3$ . Then
  - (a) this is not possible
  - (b)  $P(z) = Q(z)$  for every complex number  $z$
  - (c)  $P(z) = Q(z)$  for some complex numbers  $z$  but not all
  - (d)  $P(z) = Q(z)$  only for every real number  $z$
3. For two events  $A$  and  $B$  if  $P(A) = \frac{3}{4}$  and  $P(B) = \frac{3}{8}$  then  $P(A \cup B)$ 
  - (a) is  $\frac{3}{8}$
  - (b) is  $< \frac{3}{4}$
  - (c) is  $\frac{1}{2}$
  - (d) is  $\geq \frac{3}{4}$
4. Let  $\sum a_n$  be an absolutely convergent series. Then  $\sum (a_n)^n$  is a
  - (a) absolutely convergent series
  - (b) divergent series
  - (c) conditionally convergent series
  - (d) none of the above

5. Let  $\{a_n\}$  be a sequence such that  $a_n \rightarrow 1$  as  $n \rightarrow \infty$  then  $\frac{a_1 + \dots + a_n}{n^2}$
- converges to 0
  - diverges to  $\infty$
  - does not converge
  - converges to 1
6. Which of the following is a solution for  $\frac{dy}{dx} = 2\left(\frac{y}{x}\right) + \left(\frac{y}{x}\right)^2$ :
- $y = \frac{cx^2}{1 - cx}$
  - $y = \frac{x^3}{1 - cx}$
  - $y = \frac{cx^2}{1 - cx^2}$
  - none of the above
7. If A is a  $3 \times 3$  matrix in which each entry is non zero then  $A^{-1}$
- always exists but some of its entries could be zero
  - always exists and all of its entries are non zero
  - cannot exist
  - may or may not exist
8. The plane  $x = z$  has the property that all points on it are
- at the same distance from every point on the X-axis
  - at the same distance from the points (1,1,0) and (2,2,0)
  - at the same distance from the points (1,1,0) and (0,1,1)
  - at the same distance from every point on the Y-axis
9. Find the Fourier series of the function  $f(x) = \sin x + \cos x$  in the interval  $[0, 2\pi]$ .
10. A particle of mass  $m$  moves with a velocity  $\vec{v}$ . The force on the particle is given by  $\vec{F} = q\vec{v} \times \vec{B}$  for some vector  $\vec{B}$  and a scalar  $q$ . Show that the particle moves at a constant speed.