Department of Applied Mechanics

AML - 811 Advanced computational Fluid Dynamics

1/5/08 MAJOR EXAMINATION Sem II 2007-08
(CONTINUED).

Q12. Evaluate $\hat{e}_i (\vec{A} \cdot \hat{e}_i)$, where,
$\hat{e}_i$, $i = 1, 2, 3$ are orthonormal unit vectors and $\vec{A}$ is any vector (2)

Q13. State and prove the convolution theorem (4)

Q14. i) Find the Fourier Transform of $f(x)$, where

$$f(x) = \begin{cases} A & -L < x < L \\ 0 & \text{otherwise} \end{cases}$$

ii) Plot $f(x)$ and the Fourier transform $\hat{f}(k)$.
Hence show that as the function becomes broader in physical space, the Fourier Transform becomes narrower and vice versa (6)

Q15. Give one advantage and one disadvantage for
i) LES ii) DNS (4)

Q16. Consider fully developed turbulent flow of water in a pipe of diameter $D = 0.1$ m. The average velocity, $U_{av} = 5$ m/s. The integral length scale, l, is approximately $\frac{1}{4} D$ and the velocity scale for the turbulence, u', is approximately 10% of U_{av}. Estimate the number of grid points required for DNS of this flow for a section of the pipe that is 1m long.
(You may neglect wall effects and assume a uniform grid size.) (8)

X