Code No: RR322104 **RR** **Set No. 2**

III B.Tech II Semester Examinations,December 2010
COMPUTATIONAL AERODYNAMICS - I
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Finite difference approximation of $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ over a rectangular mesh (x=mh ,t=nk, m,n are integers,r= $\frac{k}{h^2}$) is represented by $U_m^{n+1} = (1-2r)U_m^n + r(U_{m+1}^n + U_{m-1}^n)$with 2^{nd} order terms.Using Taylor series expansion, obtain the local error. [16]

2. Apply the first law of thermodynamics to an infinitesimally small fluid element moving with the flow to obtain the energy equation in terms of total energy. [16]

3. Show that the mapping governed by the differential equations $\nabla^2\xi = 0, \nabla^2\eta = \frac{1}{\eta}$, maps uniformly spaced circles into a uniform rectangular grid in the computational plane. [16]

4. (a) Comment on the statement that Computational aerodynamics is also termed numerical experiments in the language of Aerospace Engineering. Justify the statement with at least one example. What are the specific advantages?
   (b) Comment on the impact of CFD on the problems of aerodynamics of road vehicles with one example [16]

5. Find the characteristics of p.d.e. given by $\frac{\partial^2 u}{\partial x^2} + 3\frac{\partial^2 u}{\partial x \partial y} + \frac{\partial^2 u}{\partial y^2} = 0$ [16]

6. The partial differential equation $\frac{\partial T}{\partial t} = \alpha\frac{\partial^2 T}{\partial x^2}$, represents unsteady thermal conduction in 1-Dimension. Find the type of partial differential equation & solve the equation.[16]

7. Consider the function $\phi(x, y) = e^x + e^y$ .Consider the point (x,y) =(1,1).Use first order central differences, with Δx=Δy=0.02, to calculate approximate values of $\frac{\partial \phi}{\partial x}$and $\frac{\partial \phi}{\partial y}$ at (1,1).Calculate the percentage difference when compared with the exact solution at (1,1). [16]

8. Consider the conservation form of equations of motion in fluid mechanics. How do these equations differ from the non-conservation form of these equations? Hence discuss the differences between integral and differential forms of equations. [16]

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Code No: RR322104 **RR** **Set No. 4**

III B.Tech II Semester Examinations,December 2010
COMPUTATIONAL AERODYNAMICS - I
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Apply the first law of thermodynamics to an infinitesimally small fluid element moving with the flow to obtain the energy equation in terms of total energy. [16]

2. Find the characteristics of p.d.e. given by $\frac{\partial^2 u}{\partial x^2} + 3\frac{\partial^2 u}{\partial x \partial y} + \frac{\partial^2 u}{\partial y^2} = 0$ [16]

3. (a) Comment on the statement that Computational aerodynamics is also termed numerical experiments in the language of Aerospace Engineering. Justify the statement with at least one example. What are the specific advantages?
   (b) Comment on the impact of CFD on the problems of aerodynamics of road vehicles with one example [16]

4. Finite difference approximation of $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ over a rectangular mesh (x=mh ,t=nk, m,n are integers,r= $\frac{k}{h^2}$) is represented by $U_m^{n+1} = (1-2r)U_m^n + r(U_{m+1}^n + U_{m-1}^n)$with 2^{nd} order terms.Using Taylor series expansion, obtain the local error. [16]

5. Show that the mapping governed by the differential equations $\nabla^2\xi = 0,\nabla^2\eta = \frac{1}{\eta}$, maps uniformly spaced circles into a uniform rectangular grid in the computational plane. [16]

6. The partial differential equation $\frac{\partial T}{\partial t} = \alpha\frac{\partial^2 T}{\partial x^2}$, represents unsteady thermal conduction in 1-Dimension. Find the type of partial differential equation and solve the equation.[16]

7. Consider the conservation form of equations of motion in fluid mechanics. How do these equations differ from the non-conservation form of these equations? Hence discuss the differences between integral and differential forms of equations. [16]

8. Consider the function $\phi(x, y) = e^x + e^y$ .Consider the point (x,y) =(1,1).Use first order central differences, with Δx=Δy=0.02, to calculate approximate values of $\frac{\partial \phi}{\partial x}$and $\frac{\partial \phi}{\partial y}$ at (1,1).Calculate the percentage difference when compared with the exact solution at (1,1). [16]

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Code No: RR322104 **RR** **Set No. 1**

III B.Tech II Semester Examinations,December 2010
COMPUTATIONAL AERODYNAMICS - I
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Find the characteristics of p.d.e. given by $\frac{\partial^2 u}{\partial x^2} + 3\frac{\partial^2 u}{\partial x \partial y} + \frac{\partial^2 u}{\partial y^2} = 0$ [16]

2. Consider the conservation form of equations of motion in fluid mechanics. How do these equations differ from the non-conservation form of these equations? Hence discuss the differences between integral and differential forms of equations. [16]

3. Apply the first law of thermodynamics to an infinitesimally small fluid element moving with the flow to obtain the energy equation in terms of total energy. [16]

4. Finite difference approximation of $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ over a rectangular mesh (x=mh ,t=nk, m,n are integers,r= $\frac{k}{h^2}$) is represented by $U_m^{n+1} = (1-2r)U_m^n + r(U_{m+1}^n + U_{m-1}^n)$with 2^{nd} order terms.Using Taylor series expansion, obtain the local error. [16]

5. Show that the mapping governed by the differential equations $\nabla^2\xi = 0$,$\nabla^2\eta = \frac{1}{\eta}$, maps uniformly spaced circles into a uniform rectangular grid in the computational plane. [16]

6. (a) Comment on the statement that Computational aerodynamics is also termed numerical experiments in the language of Aerospace Engineering. Justify the statement with at least one example. What are the specific advantages?
   (b) Comment on the impact of CFD on the problems of aerodynamics of road vehicles with one example [16]

7. The partial differential equation $\frac{\partial T}{\partial t} = \alpha\frac{\partial^2 T}{\partial x^2}$, represents unsteady thermal conduction in 1-Dimension. Find the type of partial differential equation and solve the equation.[16]

8. Consider the function $\phi(x, y) = e^x + e^y$ .Consider the point (x,y) =(1,1).Use first order central differences, with Δx=Δy=0.02, to calculate approximate values of $\frac{\partial \phi}{\partial x}$and $\frac{\partial \phi}{\partial y}$ at (1,1).Calculate the percentage difference when compared with the exact solution at (1,1). [16]

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Code No: RR322104 **RR** **Set No. 3**

III B.Tech II Semester Examinations,December 2010
COMPUTATIONAL AERODYNAMICS - I
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. The partial differential equation $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$, represents unsteady thermal conduction in 1-Dimension. Find the type of partial differential equation and solve the equation.[16]

2. Show that the mapping governed by the differential equations $\nabla^2 \xi = 0, \nabla^2 \eta = \frac{1}{\eta}$, maps uniformly spaced circles into a uniform rectangular grid in the computational plane. [16]

3. Consider the conservation form of equations of motion in fluid mechanics. How do these equations differ from the non-conservation form of these equations? Hence discuss the differences between integral and differential forms of equations. [16]

4. (a) Comment on the statement that Computational aerodynamics is also termed numerical experiments in the language of Aerospace Engineering. Justify the statement with at least one example. What are the specific advantages?
   (b) Comment on the impact of CFD on the problems of aerodynamics of road vehicles with one example [16]

5. Find the characteristics of p.d.e. given by $\frac{\partial^2 u}{\partial x^2} + 3\frac{\partial^2 u}{\partial x \partial y} + \frac{\partial^2 u}{\partial y^2} = 0$ [16]

6. Consider the function $\phi(x, y) = e^x + e^y$ .Consider the point (x,y) =(1,1).Use first order central differences, with Δx=Δy=0.02, to calculate approximate values of $\frac{\partial \phi}{\partial x}$and $\frac{\partial \phi}{\partial y}$ at (1,1).Calculate the percentage difference when compared with the exact solution at (1,1). [16]

7. Apply the first law of thermodynamics to an infinitesimally small fluid element moving with the flow to obtain the energy equation in terms of total energy. [16]

8. Finite difference approximation of $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ over a rectangular mesh (x=mh ,t=nk, m,n are integers,r= $\frac{k}{h^2}$) is represented by $U_m^{n+1} = (1-2r)U_m^n + r(U_{m+1}^n + U_{m-1}^n)$with 2^{nd} order terms.Using Taylor series expansion, obtain the local error. [16]

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