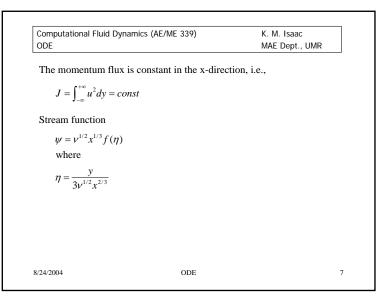


Computational Fluid Course Outline 2	d Dynamics (AE/ME 339)	K. M. Isaac MAE Dept., UMR
	ourse Outline (continue	
• Couette		
	ock tube problem uction to packaged codes:	
	Grid generation	
Р	roblem setup	
-	olution	
Turbule	ence modeling	
8/24/2004	ODE	3

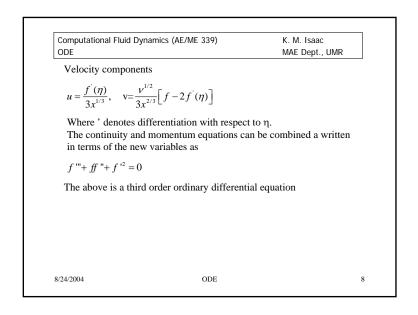
Course Outline 1	K. M. Isaac MAE Dept., UMR
Course Outline • Ordinary differential equations (ODE) • Numerical techniques for solving ODEs • Example: Laminar Free Jet • Partial differential equations, classification • Discretization of derivatives • Errors and analysis of stability • Example: Unsteady heat conduction in a root • Example: Natural convection at a heated ve	
Discretization techniques	

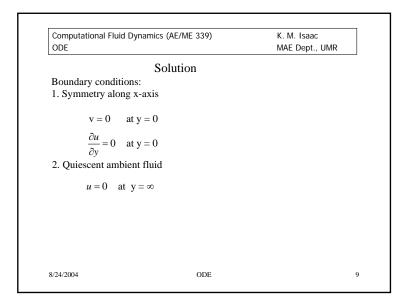
omputational Fluid Dynamics (AE/ME 339)	K. M. Isaac
	MAE Dept., UMR
ODEs and PDEs may be discretized	-approximated-
as a set of algebraic equations and set	olved
Discretization methods for ODEs ar	e well known
e.g., Runge-Kutta methods for initia and shooting methods for BV proble	I I
PDEs involve more than 1 independ	ent variable
e.g., x, y, z, t in Cartesian coordinate	es for time-dependent
Problems	
PDEs can be discretized using finite	difference
Methods ODE	4

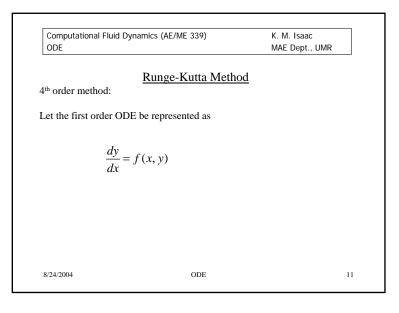
Computational Fluid Dynamics (AE/ME 339)	K. M. Isaac	
ntroduction 2	MAEEM Dept., UMR	
PDEs can also be discretized in	integral form	
known as finite volume method	-	
	-	
Sometimes coordinate transform	nation is necessary	
before discretization		
8/24/2004 ODE		



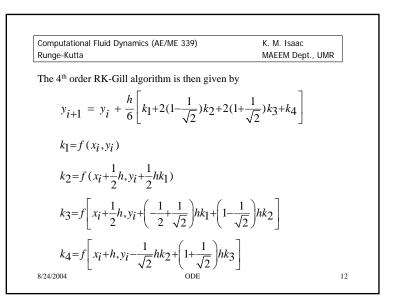
Computational Fluid Dynamics (AE/ME 339)	K. M. Isaac
ODE	MAE Dept., UMR
Plane Laminar Free J	et
Ref: F. M. White, Viscous Fluid Flow	
The jet emerges from a slit into ambient qu	
The static pressure can be assumed to be co	onstant.
Continuity equation	
$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$	
Momentum equation	
$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} \approx v\frac{\partial^2 u}{\partial y^2}$	
8/24/2004 ODE	







	amics (AE/ME 339)	K. M. Isaac
ODE		MAE Dept., UMR
The above boundary c	conditions can be written	in terms of $f$ as
f(0) = 0,  f''(0) =	= 0, and $f'(\infty) = 0$	
This is known as a bo	oundary value problem.	
•	are specified at two bound	· · · · · ·
an initial value proble at one location.	em in which all the bound	dary conditions are specified
	such as RK can be used	as follows:
Guess f'(0) and solve		
If not adjust the value specified tolerance.	e of f'(0) so as to make $f$	$f'(\infty) = 0$ to within a



Computational Fluid Dynamics	(AE/ME 339)	K. M. Isaac
Runge-Kutta		MAEEM Dept., UMR
The method can be used for	coverel cimultanee	us first order equations
The method can be used for as well as a single higher-or		us mst-order equations
See any numerical methods		

