19-9-23

COURSE STRUCTURE

A NUMERICAL SOLUTION OF HYPERBOLIC EQUATIONS

ASSIGN. 1

1 ADVECTION EQUATION

- BASIC CONCEPTS OF NUMERICAL SIMULAT.
- ACCURACY AND STABILITY
- FEW FINITE DIFFERENCE SCHEMES

ASSIGN. 2

2 SYSTEMS OF 2 HYPERBOLIC EQUATIONS

PRACTICAL EXAMPLES:
- ELASTIC WAVES IN SOLIDS
- PRESSURE WAVES IN FLUIDS
- ELECTROMAGNETIC WAVES IN CABLES

NUMERICAL METHODS
- METHOD OF CHARACTERISTICS
- FEW FINITE DIFFERENCE SCHEMES

B FUNDAMENTAL EQUATIONS GOVERNING WAVES
- SIMPLE HARMONIC OSCILLATOR
- 2 COUPLED OSCILLATORS
- TRAVELLING WAVES

- DERIVE ALL EQUATIONS SOLVED IN PART A

ASSESSMENT:

ASSIGNMENT	1	35%
"	2	65%

TIMETABLE: 2h LECTURES /WEEK

2h COMPUTING CLASS

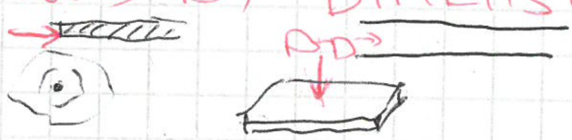
INTRODUCTION

WAVES: DISTURBANCES OF A SYSTEM WHICH PROPAGATE THROUGH THE SYSTEM FROM ONE REGION TO ANOTHER

EXAMPLES: OCEAN WAVES, SOUND, LIGHT, SEISMIC WAVES, X-RAYS, RADIO WAVES

TYPES OF WAVES REGARDING THE MEDIUM:
- MECHANICAL (NEED A MEDIUM)
- ELECTROMAGNETIC (CAN TRAVEL IN A VACUUM)

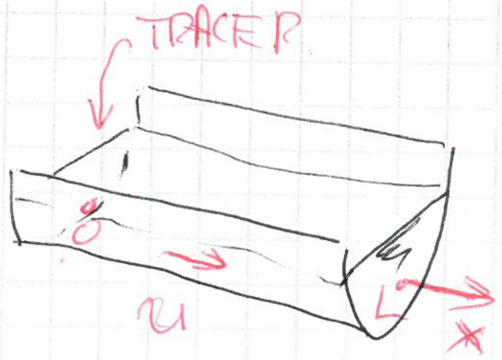
TYPES OF WAVES BY DIMENSIONALITY
- 1D
- 2D
- 3D



PART A NUMERICAL SOLUTIONS OF HYPERBOLIC EQUATIONS

1. ADVECTION EQUATION

MODEL HYPERBOLIC EQUATION. IT DESCRIBES THE MOVEMENT OF A TRACER BY A FLUID



$$\frac{\partial c}{\partial t} + u\frac{\partial c}{\partial x} = 0$$

C - TRACER CONCENTRATION $[kg/m^3]$

u - FLUID VELOCITY $[m/s]$

x, t - SPACE, TIME
$[m]$ $[s]$

1.1 NUMERICAL SOLUTION OF THE ADVECTION EQUATION (AE)

AE IS A FIRST ORDER (ONLY FIRST DERIVATIVES) PARTIAL DIFFERENTIAL EQUATION (PDE)

AE CONTAINS:

- 2 INDEPENDENT VARIABLES: x, t
- 1 KNOWN PARAMETER: u
- 1 UNKNOWN VARIABLE: C

IN ORDER TO BE ABLE TO SOLVE IT WE NEED TO KNOW:

- SIMULATION DOMAIN: $0 \leq x \leq L$
- SIMULATION TIME: $0 \leq t \leq T$
- INITIAL CONDITION: $C(0 \leq x \leq L, t=0)$
- BOUNDARY CONDITION: $C(x=0, 0 \leq t \leq T)$