A quick review of topics covered in CIVL 1101
- Measuring distance
- Measuring elevations using differential leveling
- Conducting a topographic surveying
- Developing a contour map/model

Distance Measurement
- Distance is one of the most basic engineering measurements
- The four techniques we use are:
  - Pacing
  - Measuring wheel
  - Taping or chaining
  - Electronic distance measuring (EDM) devices

Distance Measurement
Pacing
- The ability to pace distance is very useful
- A person can determine their pace by counting the number of paces necessary to walk a distance that has been previously measured
- A pace is defined as one step
- A stride is consider two steps

Distance Measurement
Taping or Chaining
- For centuries engineers have measured distances with ropes, lines, or cords
- The term chaining is a carry-over from the time when the Gunter chain was used (1600's)
- The 66 foot chain is made of 100 7.92 inch links
- Tapes are available in lengths up to 1000 feet; precision of 1/1000 to 1/5000 are commonly obtained
Distance Measurement

Electronic Distance Measurements (EDM)

- EDMs are very useful in measuring distances that are difficult to access or long distances.

- EDMs measure the time required for a light wave to sent to a target and reflected back.

<table>
<thead>
<tr>
<th>Distance Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pacing</strong></td>
</tr>
<tr>
<td><strong>1/50 to 1/200</strong></td>
</tr>
<tr>
<td><strong>Odometer</strong></td>
</tr>
<tr>
<td><strong>1/200</strong></td>
</tr>
<tr>
<td><strong>Taping</strong></td>
</tr>
<tr>
<td><strong>1/1000 to 1/5000</strong></td>
</tr>
<tr>
<td><strong>EDM</strong></td>
</tr>
<tr>
<td><strong>±0.04 to 1/300,000</strong></td>
</tr>
</tbody>
</table>

Distance Measurement

Taping over Sloping Ground

- If the taping is done over sloping ground where there is no underbrush, the taping must be done in sections, referred to as: breaking the tape.

- Hold the tape level.
- Use a plumb bob to locate the point.
- Height less than 5 feet.

Differential Leveling

Definitions

- BS = 6.32 ft
- HE = 106.32 ft
- FS = 3.10 ft

Elevation = 103.22 ft
Point B
Point A
Starting point (elevation 100.00 ft)
Differential Leveling

Definitions

- **Bench mark (BM)** - relatively permanent point of known elevation
- **Backsight (BS)** - a sight taken to the level rod held at a point of known elevation (either a BM or TP)
- **Height of instrument (HI)** - the elevation of the line of sight of the telescope
- **Foresight (FS)** - a sight taken on any point to determine its elevation

Level Instrument

Computation of Elevations

<table>
<thead>
<tr>
<th>Point</th>
<th>BS</th>
<th>HI</th>
<th>FS</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM₁</td>
<td>12.64</td>
<td>112.64</td>
<td>3.10</td>
<td>100.00</td>
</tr>
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</table>
### Differential Leveling

**Computation of Elevations**

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<td>100.00</td>
<td></td>
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<tr>
<td>TP₁</td>
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<td>120.41</td>
<td>3.11</td>
<td>109.53</td>
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<tr>
<td>TP₂</td>
<td>9.72</td>
<td>127.57</td>
<td>2.56</td>
<td>117.85</td>
</tr>
<tr>
<td>BM₂</td>
<td>9.72</td>
<td>127.57</td>
<td>3.10</td>
<td>124.47</td>
</tr>
</tbody>
</table>
Differential Leveling

**Computation of Elevations**

- Check the summation of the backsight and the foresight with the change in elevation.

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<tbody>
<tr>
<td>BM1</td>
<td>12.64</td>
<td>112.64</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>10.88</td>
<td>120.41</td>
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</tr>
<tr>
<td>TP2</td>
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<td>127.57</td>
<td>2.56</td>
<td>117.85</td>
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<tr>
<td>BM2</td>
<td>3.10</td>
<td></td>
<td>3.10</td>
<td>124.47</td>
</tr>
</tbody>
</table>

Change in elevation = 33.24 - 8.77 = 24.47

Topographic Survey

**Introduction**

- **Topography** - defined as the shape or configuration or relief or three-dimensional quality of a surface.
- Topography maps are very useful for engineers when planning and locating a structure.

**Contours**

- The most common method of representing the topography of an area is to use *contour lines*.
- *A contour line* is an imaginary level line that connects points of equal elevation.

- Closely spaced contours indicate steep slopes.
- Widely spaced contours indicate moderate slopes.
- Contours should be labeled to the elevation value.
- Contours are not shown going through buildings.
- Contour lines do not cross.
Characteristics of Contours

- Contour lines do begin or end on the plan.
- Depression and hill look the same; note the contour value to distinguish the terrain.
- Important points can be further defined by including a "spot" elevation.
- Contour lines tend to parallel each other on uniform slopes.

Construction of Contours

- The first step in developing a contour map is measuring the elevations of a group of points.
- It will be easier for us to establish a rectangular grid of points (marked with flags) and measure the elevation.
- The location of the flag points can be established by taping and checked by pacing or the odometer.

Once your contour grid is established, measure the elevation of each grid point.

The basic method for estimating contour is applied to each grid cell individually.

Use linear interpolation to find the location of the desired contour interval.

Let consider the cell in the upper left-hand corner - remember the contour interval is 5 ft.

We want a contour map on 5 ft intervals.

The grid is rectangular, the dimensions of the sides are 50 ft (north) and 100 ft (east).
Construction of Contours

First see if a contour interval exist between nodes of the grid cell; so, estimate where along the side the contour interval would be located if

Apply simple linear interpolation to each side to locate the contour interval

Let's look at the top edge of the grid cell

Let's look at the bottom edge of the grid cell

Let's look at the left edge of the grid cell

Let's look at the right edge of the grid cell

Locate the contour intervals locations on the grid cell

Next, simply connect points of equal contour intervals

One grid cell down, eight to go . . .
Repeating the linear interpolation for each of the remaining grid cell gives: