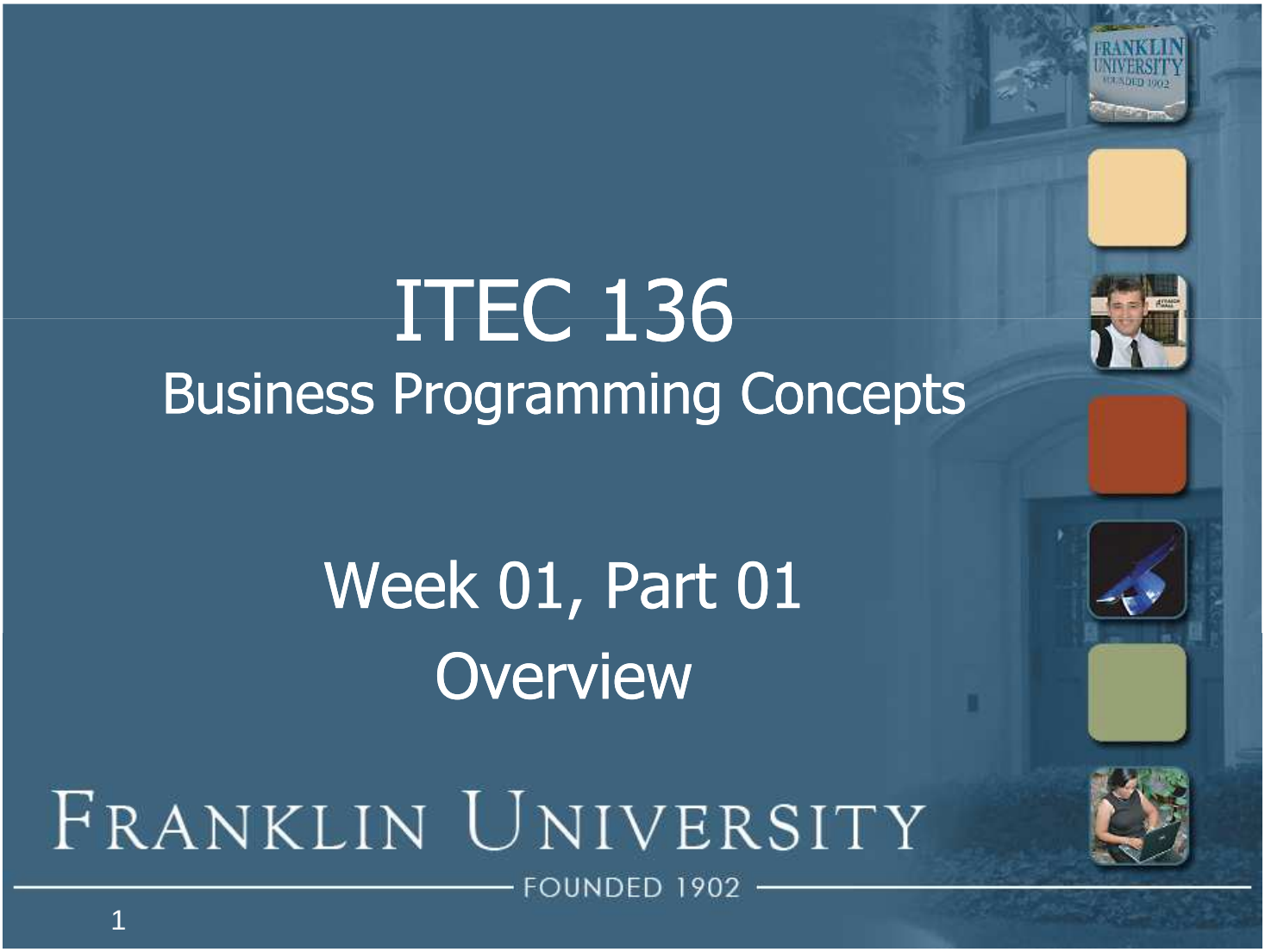


Week 7 Overview

- Week 6 review
  - Four parts to every loop
    - Initialization
    - Condition
    - Body
    - Update
  - Pre-test loops: condition is evaluated before body is executed

Week 7 Overview

- Week 6 review
  - Post-test loops: condition is evaluated after the body is executed
  - `while` loops: condition and body are explicit. Initialization and update still need to be present

```
initialization;
while (condition) {
    body_statements;
    update_statement;
}
```


Week 7 Overview

- Week 6 review
  - `for` loops: all four elements are explicit. Often used when bounds are explicitly known (i.e. counting loops).

```
for (initialization; condition; update) {
       body_statements;
}
```

Week 7 Overview

- Week 6 review
  - do…while loops: two elements explicit, the only post-test loop.

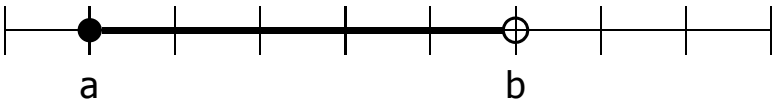
```
initialization;
do {
    body_statements;
    update;
} while (condition);
```


Week 7 Overview

- Week 6 review
  - Common loop errors
    - Off-by-one: one too many or one too few executions of the body
    - Infinite loops: never stops because the condition never becomes false
    - Body never executes: condition is false initially

Week 7 Overview

- Week 6 review
  - How programmers count
    - Always start with zero
    - Always use < as the comparison operator
    - Left bound included, right bound excluded. E.g. [a, b)



Week 7 Overview

- Outcomes
  - Implement algorithms requiring nested loops.
  - Differentiate between various loop termination conditions such as sentinels, results-controlled, symmetric and asymmetric bounds, and counting.

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Business Programming Concepts

Week 07, Part 02

Termination conditions

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Termination conditions

- The condition terminates loops when it becomes false
  - Saw counting loops last week [e.g. `while (counter < max)`]
  - But, there are many different kinds of Boolean conditions.

Termination conditions

- Sentinels
  - Sentinels "guard" something, and in this case it is the end of the loop.
  - Commonly used for and end-of-data condition.

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Termination conditions

- Sentinels
  - Ex: read numbers until a non-number is entered (non-number is the sentinel)

```
function readData() {
    var data = prompt("Enter data (cancel to quit)");
    while (data != null) {
        // do somethign with the data here
        data = prompt("Enter data (cancel to quit)")
    }
}
```


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Termination conditions

- Sentinels
  - Ex: read numbers until a non-number is entered (non-[illegible]tinel)

```
function readData() {
    var data = prompt("Enter data (cancel to quit)");
    while (data != null) {
        // do something with the data here
        data = prompt("Enter data (cancel to quit)")
    }
}
```

`null` guards the end of input (it is what `prompt` returns when the user clicks "cancel."

Termination conditions

- Sentinels
  - Any kind of data that shouldn't appear in the input stream can be a sentinel
    - A negative number
    - Zero
    - A special string

Termination conditions

- Flag controlled loops
  - Often, the termination condition can't be detected until the middle of the body.
  - Use a Boolean flag "done" set to false initially to enter the loop.
  - When the condition is detected, set done to `true`.

Termination conditions

- Flag controlled loops

```
function readData() {
  var done = false;
  while (!done) {
    var data = prompt("Enter data (cancel to quit)");
    if (data == null) {
      done = true;
    } else {
      // do something with data here
    }
  }
}
```

Termination conditions

- Flag controlled loops

```
function readData() {
  var done = false;
  while (!done) {
    var data = prompt("Enter data (cancel to quit)");
    if (data == null) {
      done = true;
    } else {
      // do something with data here
    }
  }
}
```

Set the flag so that the loop is entered initially

Termination conditions

- Flag controlled loops

```
function readData() {
  var done = false;
  while (!done) {
    var data = prompt("Ent                    ");
    if (data == null) {
      done = true;
    } else {
      // do something with data here
    }
  }
}
```

When the termination condition is detected, set the flag so that the loop will exit.

Termination conditions

- Result controlled loops
  - Body of the loop is calculating a value and we want to keep iterating until that value falls within a certain range.
  - The result of the body calculation controls the termination condition.
  - Ex: how many years of investing $10K at 5% interest to reach $1M?

Termination conditions

- Result controlled loops

```
function yearsToReach(target, principle, rate) {
    var years = 0;
    var total = 0;
    while (total < target) {
        total += principle;
        total *= (1.0 + rate)
        ++years;
    }
    return years;
}
```

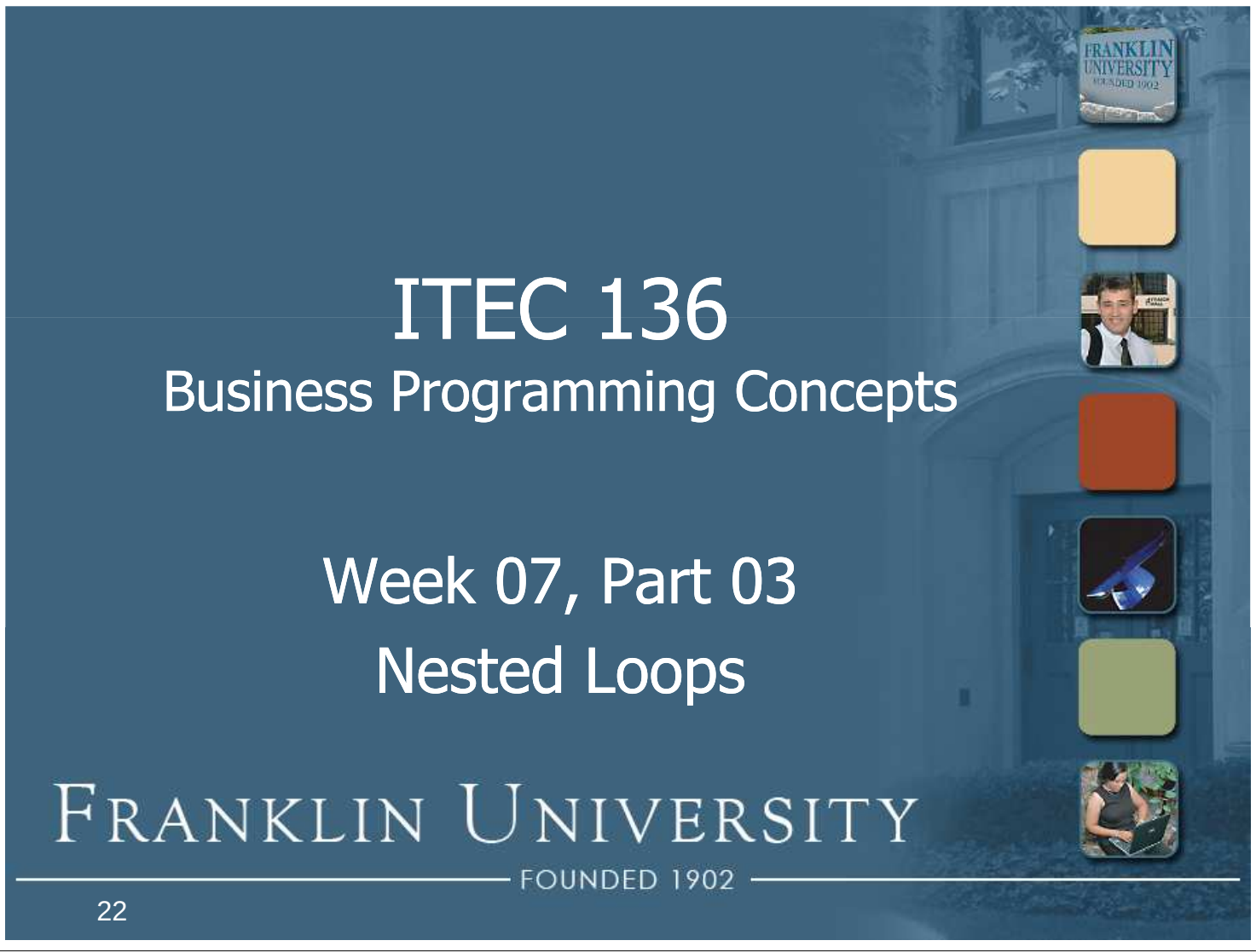
We calculate the total in the body...

Termination conditions

- Result controlled loops

```
function yearsToReach(target, principle, rate) {
    var years = 0;
    var total = 0;
    while (total < target) {
        total += principle;
        total *= (1.0 + rate)
        ++years;
    }
    return years;
}
```

...and use the result in the condition.



Nested loops

- Nested loops are loops within loops
  - Key times used: when you're not just calculating/outputting/inputting something in a straight line, but rather when it is 2-dimensional
  - Example: triangles

```
*
**
***
****
*****
```


Nested loops

- Example: triangles

```
function makeTriangle1(height, ch){
    var str = "";
    for (var row = 0; row < height; ++row) {
        for (var col = 0; col < row + 1; ++col) {
            str += ch;
        }
        str += "<br />";
    }
    return str;
}
```

Nested loops

- Example: triangles

```
function makeTriangle1(height
    var str = "";
    for (var row = 0; row < height; ++row) {
        for (var col = 0; col < row + 1; ++col) {
            str += ch;
        }
        str += "<br />";
    }
    return str;
}
```

For each row in the triangle...

For each column within the row...

Nested loops

- Example: triangles

```
function makeTriangle1(height
    var str = "";
    for (var row = 0; row < height; ++row) {
        for (var col = 0; col < row + 1; ++col) {
            str += ch;
        }
        str += "<br />";
    }
    return str;
}
```

The counter in the outer loop...

...becomes part of the condition in the inner loop.

Nested loops

- Example: triangles

```
function makeTriangle1(height, ch){
    var str = "";
    for (var row = 0; row < height; ++row) {
        for (var col = 0; col < row + 1; ++col) {
            str += ch;
        }
        str += "<br />";
    }
    return str;
}
```

What would this look like if we substituted "height" for "row + 1"

Nested loops

- Hiding nested loops: functions
  - Function A has a loop, and within that loop, it calls function B
  - Function B has a loop. Therefore this situation is a loop-within-a-loop, but it doesn't look as complicated!

Nested loops

- Hiding nested loops: functions

```
function isPrime(num) {
    if (num % 2 == 0) {
        return false;
    }
    for (var i = 3; i < Math.sqrt(num); i += 2) {
        if (num % i == 0) {
            return false;
        }
    }
    return true;
}
```


Nested loops

- Hiding nested loops: functions

```
function isPrime(num) {
    if (num % 2 == 0) {
        return false;
    }
    for (va
        if
        }
    }
    return
}
```

```
function primesBetween(start, end) {
    for (var i = start; i < end; ++i) {
        if (isPrime(i)) {
            document.writeln(i + "<br />");
        }
    }
}
```

Nested loops

- Hiding nested loops: functions

```
function isPrime(num) {
    if (num % 2 == 0) {
        return false;
    }
    for (va
        if
        }
    }
    retur
}
```

```
function primesBetween(start, end) {
    for (var i = start; i < end; ++i) {
        if (isPrime(i)) {
            document.writeln(i + "<br />");
```

The call to `isPrime` is inside a loop...

And `isPrime` has a loop. Therefore, this is a nested loop in disguise.

A semi-complicated example

- Printing out a calendar
  - Does this involve a nested loops? Why or why not?
  - Given: number of days in month, and a starting day, print the calendar.

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Nested loops

- Printing a calendar

```
function makeCalendar(days, startDay){
    var str = "<table border='1'><tr>";
    var i, j;
    for (i = 0; i < startDay - 1; ++i) {
        str += "<td> </td>"
    }
    for (j = 0; j < days; ++j, ++i) {
        if (i % 7 == 0) {
            str += "</tr><tr>"
        }
        str += "<td>" + (j + 1) + "</td>";
    }
```


Nested loops

- Printing a calendar

```
function makeCalendar(days, startDay){
    var str = "<table border='1'><tr>";
    var i, j;
    for (i = 0; i < startDay - 1; ++i) {
        str += "<td> </td>"
    }
    for (j = 0; j < days; ++j, ++i)
        if (i % 7 == 0) {
            str += "</tr><tr>"
        }
        str += "<td>" + (j + 1) + "</td>";
    }
```

Prints the leading "empty" boxes

Nested loops

- Printing a calendar

```
function makeCalendar(days, startDay){
    var str = "<table border='1'><tr>";

    for (i = 0; i < startDay - 1; ++i) {
        str += "<td> </td>"
    }
    for (j = 0; j < days; ++j, ++i) {
        if (i % 7 == 0) {
            str += "</tr><tr>"
        }
        str += "<td>" + (j + 1) + "</td>";
    }
```

Prints the "filled" boxes

Prints the leading "empty" boxes

Nested loops

- Printing a calendar

```
    while (i % 7 != 0) {
        str += "<td> </td>";
        ++i;
    }
    str += "</tr></table>"
    return str;
}
```

Nested loops

- Printing a calendar

```
    while (i % 7 != 0) {
        str += "<td> </td>"
        ++i;
    }
    str += "</tr></table>"
    return str;
}
```

Prints the trailing "empty" boxes

Nested loops

- Printing a calendar
  - Just because something is 2-D in the "real world" doesn't mean that the problem necessarily involves nested loops!

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Business Programming Concepts

Week 07, Part 04

Changing control flow

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Changing control flow

- Three keywords alter the flow of control in a loop:
  - `break` – this keyword immediately stops executing the loop, and jumps out to the next statement following the loop.

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Changing control flow

- Three keywords alter the flow of control in a loop:
  - `continue` – this keyword immediately stops executing the current iteration of the body, and cycles back to the top to test the condition again.

Changing control flow

- Three keywords alter the flow of control in a loop:
  - `return` – this keyword immediately stops executing the entire function, and returns to the next statement following the function call.

Questions?

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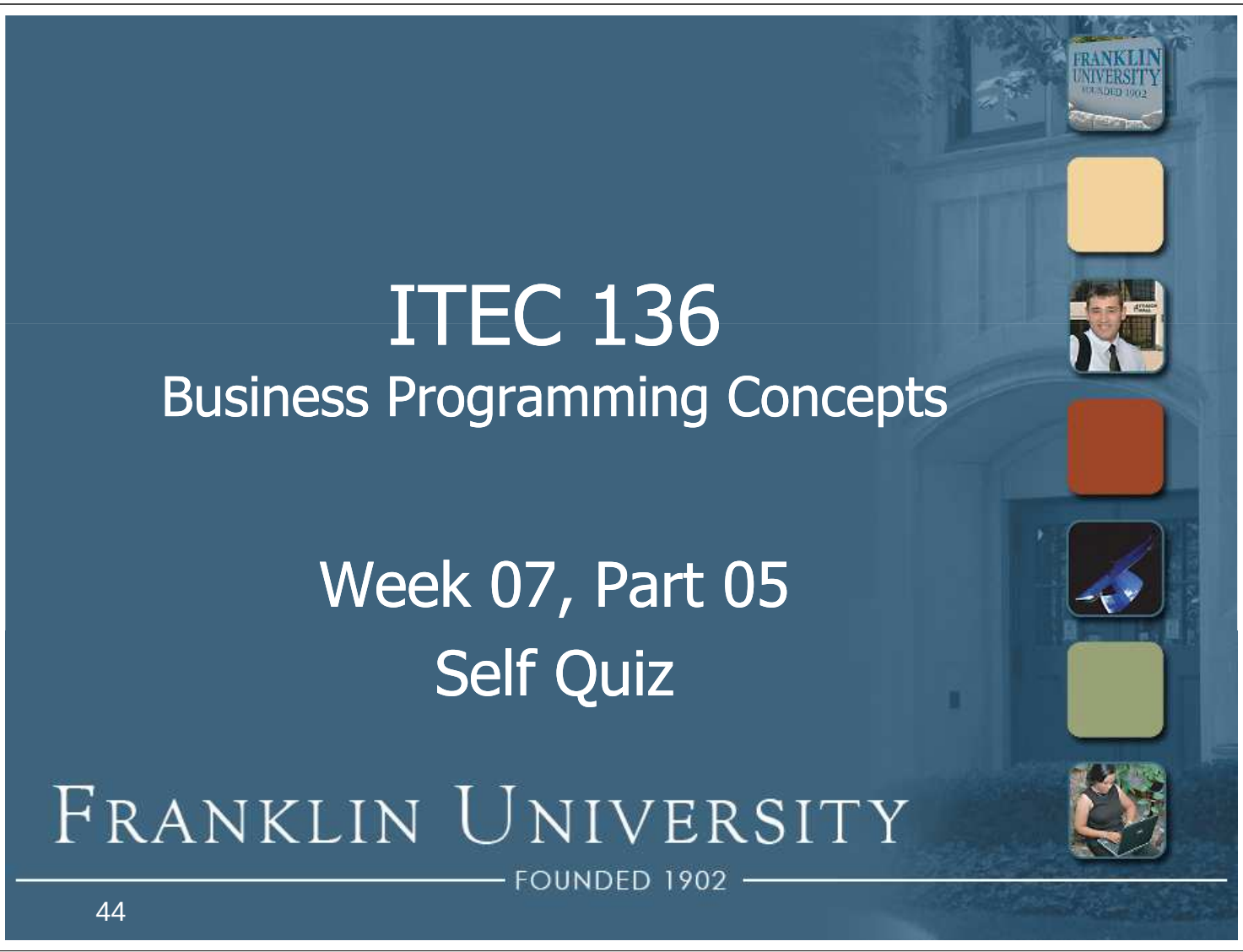

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Business Programming Concepts

Week 07, Part 05

Self Quiz

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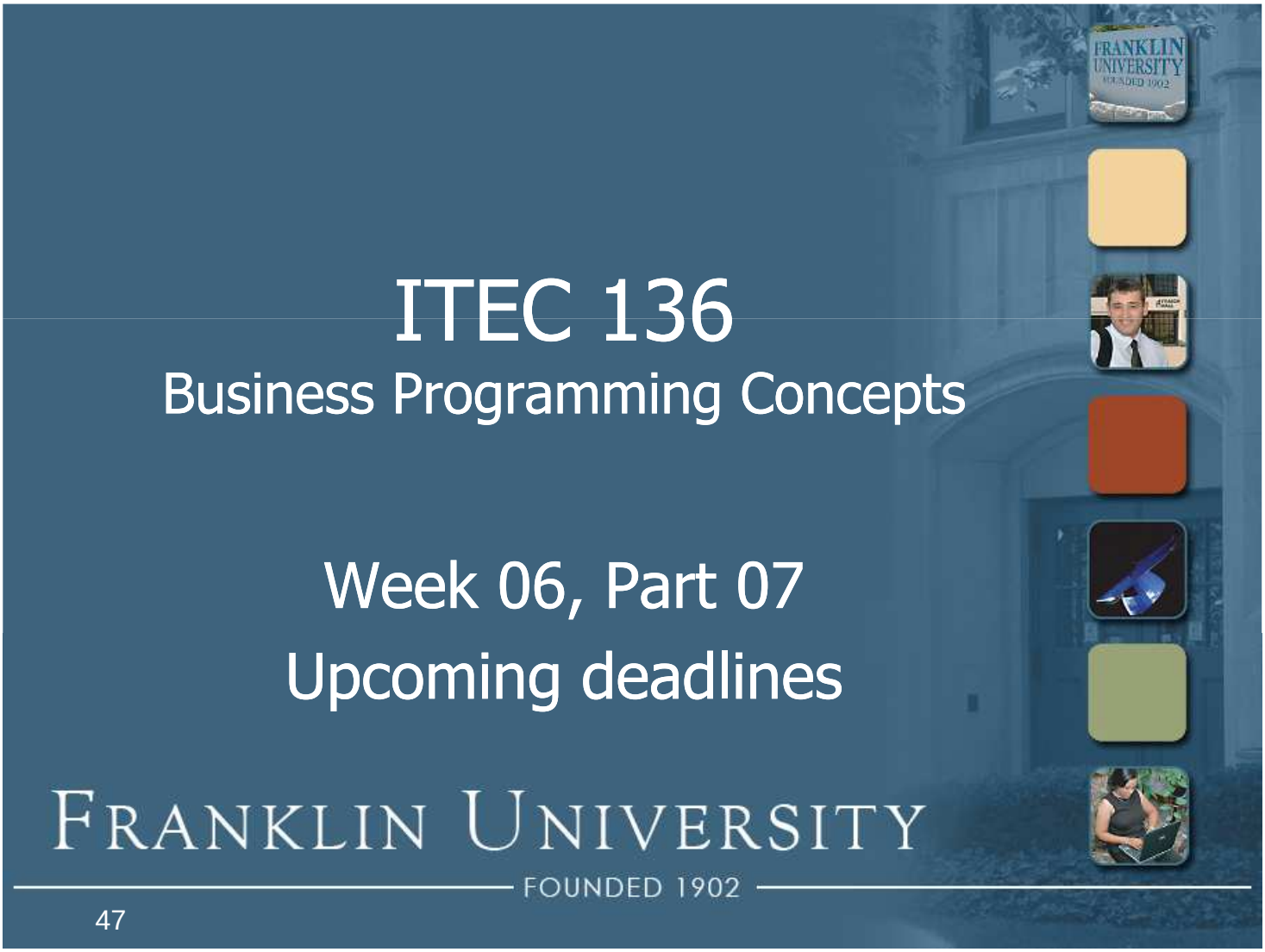
Self Quiz

- What is the key idea behind nested loops?
- What three keywords alter the flow of control in a loop?
- How do we hide the complexity of nested loops?

Self Quiz

- Given the `makeCalendar` function, can you write the code that will print out a yearly calendar with month names?



Upcoming Deadlines

- Homework 6 – Due February 23
- Lab 2 – Due February 23