

## COURSE SYLLABUS AND COURSE REQUIREMENTS

ACADEMIC YEAR 2022/2023 SEMESTER II.

<i>Course title</i>	<i>Electronics 3.</i>
<i>Course Code</i>	IVB042AN
<i>Hours/Week: le/pr/lab</i>	2/0/2
<i>Credits</i>	4
<i>Degree Programme</i>	Electrical Engineering BSc 4. s.
<i>Study Mode</i>	daytime education
<i>Requirements</i>	midsemester grade
<i>Teaching Period</i>	spring
<i>Prerequisites</i>	
<i>Department(s)</i>	Department of Automation
<i>Course Director</i>	Dr. Viktor Bagdán
<i>Teaching Staff</i>	

## COURSE DESCRIPTION

A short description of the course (max. 10 sentences).

Neptun: [Instruction/Subjects/Subject Details/Basic data/Subject description](#)

The training course, which includes presentations and reference materials, will deepen the technical expertise of experienced engineers and accelerate the development of those early in their studies.

## SYLLABUS

Neptun: [Instruction/Subjects/Subject Details/Syllabus](#)

### 1. GOALS AND OBJECTIVES

Goals, student learning outcome.

Neptun: [Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction](#)

The training courses dive into all the technical details of many key product specs. In an op amp, for example, these specs include input common mode or VCM, input offset voltage or VOS, intrinsic noise, open loop gain or AOL, bandwidth, slew rate, output swing, and stability. In addition to the specs, we will also cover some typical applications of each type of product. In the case of an op amp, these applications may include photodiode amplifier, level translator, power amplifier, voltage-to-current converter, and ADC driver.

The course is for junior level engineers and engineering students since these courses give practical knowledge about real-world devices and applications starting with the fundamentals. However, intermediate and experienced engineers can also benefit greatly, whether they are just refreshing their knowledge or diving deeper into a detailed topic. Our courses often give lesser known technical details, including info about what's going on inside an integrated circuit.

Finally, this course is also very beneficial to engineers who are transitioning from digital design to analog design. Consider it a way to quickly ramp up your analog knowledge from zero to guru.

### 2. COURSE CONTENT

Neptun: [Instruction/Subjects/Subject Details/Syllabus/Subject content](#)

#### TOPICS

#### LECTURE

1. *Op Amps: Introduction*
2. *Op Amps: Input Offset Voltage and Input Bias Current*
3. *Op Amps: Input and Output Limitations*
4. *Op Amps: Power and Temperature*
5. *Op Amps: Bandwidth*

**PRACTICE**

6. *Op Amps: Slew Rate*
7. *Introduction to Analog-to-Digital Converters (ADCs)*
8. *Analog-to-Digital Converter (ADC) Drive Topologies*
9. *Error and Noise*
10. *Common mode rejection and power supply rejection*

**LABORATORY PRACTICE**

1. *topic*
  2. *topic*
  3. *topic*
  4. *etc.*
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1. *Op Amps: Vos and Ib – Lab*
  2. *Op Amps: Vos and Ib – Lab2*
  3. *Op Amps: Input and Output Limitations 1*
  4. *Op Amps: Input and Output Limitations 2*
  5. *Op Amps: Power and Temperature*
  6. *Op Amps: Bandwidth 1*
  7. *Op Amps: Bandwidth 2*
  8. *Op Amps: Slew Rate*
  9. *ADCs: Hands-on Experiment – Crossover Distortion*
  10. *ADCs: Calculating the Total Noise for ADC Systems*

**DETAILED SYLLABUS AND COURSE SCHEDULE**

ACADEMIC HOLIDAYS INCLUDED

**LECTURE**

<i>week</i>	<b>Topic</b>	<b>Compulsory reading; page number (from ... to ...)</b>	<b>Required tasks (assignments, tests, etc.)</b>	<b>Completion date, due date</b>
1.	Course description, goals and objectives	...	...	...
2.	Op Amps: Introduction	<a href="https://training.ti.com/ti-precision-labs-op-amps?context=1139747-1139745-14685">https://training.ti.com/ti-precision-labs-op-amps?context=1139747-1139745-14685</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-national-instruments-virtualbench-overview?context=1139747-1139745-14685-1138796-12422">https://training.ti.com/ti-precision-labs-op-amps-national-instruments-virtualbench-overview?context=1139747-1139745-14685-1138796-12422</a>	learn, solve quiz questions	3 <sup>rd</sup> week
3.	Op Amps: Input Offset Voltage and Input Bias Current	<a href="https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-specifications?context=1139747-1139745-14685-1138797-14681">https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-specifications?context=1139747-1139745-14685-1138797-14681</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-lab?context=1139747-1139745-14685-1138797-14684">https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-lab?context=1139747-1139745-14685-1138797-14684</a>	learn, solve quiz questions	4 <sup>th</sup> week
4.	Op Amps: Input and Output Limitations	<a href="https://training.ti.com/ti-precision-labs-">https://training.ti.com/ti-precision-labs-</a>	learn, solve quiz questions	5 <sup>th</sup> week

	<a href="https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-non-linear-behavior?context=1139747-1139745-14685-1138798-13960">op-amps-input-and-output-limitations-non-linear-behavior?context=1139747-1139745-14685-1138798-13960</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-output-swing?context=1139747-1139745-14685-1138798-605541">https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-output-swing?context=1139747-1139745-14685-1138798-605541</a>		
5.	Op Amps: Power and Temperature	<a href="https://training.ti.com/ti-precision-labs-op-amps-power-and-temperature?context=1139747-1139745-14685-1138799-607342">https://training.ti.com/ti-precision-labs-op-amps-power-and-temperature?context=1139747-1139745-14685-1138799-607342</a>	learn, solve quiz questions 6 <sup>th</sup> week
6.	Op Amps: Bandwidth	<a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-bode-plots-cutoff-frequency?context=1139747-1139745-14685-1138800-13124">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-bode-plots-cutoff-frequency?context=1139747-1139745-14685-1138800-13124</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-gain-gbw?context=1139747-1139745-14685-1138800-13125">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-gain-gbw?context=1139747-1139745-14685-1138800-13125</a>	learn, solve quiz questions 7 <sup>th</sup> week
7.	First midterm test		
8.	Op Amps: Bandwidth	<a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-non-inverting-gain-poles?context=1139747-1139745-14685-1138800-13126">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-non-inverting-gain-poles?context=1139747-1139745-14685-1138800-13126</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909</a>	learn, solve quiz questions 9 <sup>th</sup> week
9.	Op Amps: Slew Rate	<a href="https://training.ti.com/ti-precision-labs-op-amps-slew-rate-introduction?context=1139747-1139745-14685-1138801-13228">https://training.ti.com/ti-precision-labs-op-amps-slew-rate-introduction?context=1139747-1139745-14685-1138801-13228</a> to <a href="https://training.ti.com/ti-precision-labs-">https://training.ti.com/ti-precision-labs-</a>	learn, solve quiz questions 10 <sup>th</sup> week

		op-amps-slew-rate-lab?context=1139747-1139745-14685-1138801-13231		
10.	Introduction to Analog-to-Digital Converters (ADCs)	<a href="https://training.ti.com/ti-precision-labs-adcs-dc-spec?context=1139747-1140267-1128375-1139102-1146617">https://training.ti.com/ti-precision-labs-adcs-dc-spec?context=1139747-1140267-1128375-1139102-1146617</a> to <a href="https://training.ti.com/ti-precision-labs-adcs-ac-dc-specifications-offset-error-gain-error-cmrr-psrr-snr-and-thd?context=1139747-1140267-1128375-1139102-1128657">https://training.ti.com/ti-precision-labs-adcs-ac-dc-specifications-offset-error-gain-error-cmrr-psrr-snr-and-thd?context=1139747-1140267-1128375-1139102-1128657</a>	learn, solve quiz questions	11 <sup>th</sup> week
11.	Analog-to-Digital Converter (ADC) Drive Topologies	<a href="https://training.ti.com/ti-precision-labs-adcs-sar-adc-input-types?context=1139747-1140267-1128375-1139103-1128659">https://training.ti.com/ti-precision-labs-adcs-sar-adc-input-types?context=1139747-1140267-1128375-1139103-1128659</a>	learn, solve quiz questions	12 <sup>th</sup> week
12.	Error and Noise	<a href="https://training.ti.com/ti-precision-labs-op-amps-noise-spectral-density?context=1139747-1139745-14685-1138803-13232">https://training.ti.com/ti-precision-labs-op-amps-noise-spectral-density?context=1139747-1139745-14685-1138803-13232</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-noise-lab?context=1139747-1139745-14685-1138803-13847">https://training.ti.com/ti-precision-labs-op-amps-noise-lab?context=1139747-1139745-14685-1138803-13847</a>	learn, solve quiz questions	13 <sup>th</sup> week
13.	Common mode rejection and power supply rejection	<a href="https://training.ti.com/node/1138802?context=1139747-1139745-14685-1138802">https://training.ti.com/node/1138802?context=1139747-1139745-14685-1138802</a> to <a href="https://training.ti.com/ti-precision-labs-op-amps-power-supply-rejection?context=1139747-1139745-14685-1138802-669722">https://training.ti.com/ti-precision-labs-op-amps-power-supply-rejection?context=1139747-1139745-14685-1138802-669722</a>	learn, solve quiz questions	14 <sup>th</sup> week
14.	Second midterm test			
15.	Retake of midterm tests			

**PRACTICE, LABORATORY PRACTICE**

<i>week</i>	<b>Topic</b>	<b>Compulsory reading; page number (from ... to ...)</b>	<b>Required tasks (assignments, tests, etc.)</b>	<b>Completion date, due date</b>
1.	Course description, goals and objectives, simulation programmes introduction		learn	2 <sup>nd</sup> week
2.	Installation, how to use TINA simulation program		test	3 <sup>rd</sup> week
3.	Op Amps: Vos and Ib – Lab	<a href="https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-specifications?context=1139747-1139745-14685-1138797-14681">https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-specifications?context=1139747-1139745-14685-1138797-14681</a>	learn, test	4 <sup>th</sup> week
4.	Op Amps: Vos and Ib – Lab2	<a href="https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-lab?context=1139747-1139745-14685-1138797-14684">https://training.ti.com/ti-precision-labs-op-amps-vos-and-ib-lab?context=1139747-1139745-14685-1138797-14684</a>	learn, test	5 <sup>th</sup> week
5.	Op Amps: Input and Output Limitations 1	<a href="https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-lab?context=1139747-1139745-14685-1138798-13961">https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-lab?context=1139747-1139745-14685-1138798-13961</a>	learn, test	6 <sup>th</sup> week
6.	Op Amps: Input and Output Limitations 2	<a href="https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-common-mode-voltage?context=1139747-1139745-14685-1138798-605540">https://training.ti.com/ti-precision-labs-op-amps-input-and-output-limitations-common-mode-voltage?context=1139747-1139745-14685-1138798-605540</a>	learn, test	7 <sup>th</sup> week
7.	First midterm test			
8.	Op Amps: Power and Temperature	<a href="https://training.ti.com/ti-precision-labs-op-amps-power-and-temperature?context=1139747-1139745-14685-1138799-607342">https://training.ti.com/ti-precision-labs-op-amps-power-and-temperature?context=1139747-1139745-14685-1138799-607342</a>	learn, test	9 <sup>th</sup> week
9.	Op Amps: Bandwidth 1	<a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909</a>	learn, test	10 <sup>th</sup> week
10.	Op Amps: Bandwidth 2	<a href="https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909">https://training.ti.com/ti-precision-labs-op-amps-bandwidth-lab?context=1139747-1139745-14685-1138800-38909</a>	learn, test	11 <sup>th</sup> week
11.	Op Amps: Slew Rate	<a href="https://training.ti.com/ti-precision-labs-op-amps-slew-rate-">https://training.ti.com/ti-precision-labs-op-amps-slew-rate-</a>	learn, test	12 <sup>th</sup> week

		lab?context=1139747-1139745-14685-1138801-13231		
12.	ADCs: Hands-on Experiment – Crossover Distortion	https://training.ti.com/ti-precision-labs-adcs-hands-experiment-crossover-distortion?context=1139747-1140267-1128375-1139103-1135343	learn, test	13 <sup>th</sup> week
13.	ADCs: Calculating the Total Noise for ADC Systems	https://training.ti.com/ti-precision-labs-adc-amp-examples?context=1139747-1140267-1128375-1140017-1147901	learn, test	14 <sup>th</sup> week
14.	Second midterm test			
15.	Retake of midterm tests			

## 11. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System)

### ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

**Method for monitoring attendance** (e.g.: attendance sheet / online test/ register, etc.)

attendance sheet

### ASSESSMENT

Cells of the appropriate type of requirement is to be filled out (course-units resulting in mid-term grade or examination). Cells of the other type can be deleted.

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**Course resulting in mid-term grade (PTE TVSz 40§(3))**

**Mid-term assessments, performance evaluation and their ratio in the final grade** (The samples in the table to be deleted.)

Type	Assessment	Ratio in the final grade
Lecture midterm test 1	max 30 points	25 %
Lecture midterm test 2	max 30 points	25 %
Laboratory midterm test 1	max 30 points	25 %
Laboratory midterm test 2	max 30 points	25 %

**Opportunity and procedure for re-takes** (PTE TVSz 47§(4))

The specific regulations for improving grades and resitting tests must be read and applied according to the general Code of Studies and Examinations. E.g.: all tests and assessment tasks can be repeated/improved at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

Opportunity for retakes: 8th week (first tests), 15th week (second tests)

### Grade calculation as a percentage

based on the aggregate performance according to the following table

Course grade	Performance in %
excellent (5)	85 % ...
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

## 12. SPECIFIED LITERATURE

*In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)*

### **COMPULSORY READING AND AVAILABILITY**

1. <https://training.ti.com/ti-precision-labs-overview?context=1139747>

### **RECOMMENDED LITERATURE AND AVAILABILITY**

1. Tim Green, Pete Semig and Collin Wells: Analog Engineer's Circuit Cookbook: Op Amps
2. Art Kay, Luis Chioye and Dale Li: Analog Engineer's Circuit Cookbook: ADCs
3. Art Kay and Tim Green: Analog Engineer's Pocket Reference
4. Getting Started with TINA-TI™ (SBOU052A–August 2007–Revised August 2008)