Mittuniversitetet
MID SWEDEN UNIVERSITY

Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
E L 0 4 1 A	T 1 0 1	2 0 1 8 - 1 2 - 0 7

Kursnamn	Elektronik AV, Sensorer och instrumentering
Provnamn	Teori del 1: Skriftlig tentamen
Ort	Sundsvall
Termin	
Ämne	

6895642268

Utskriven 2018-12-12 kl. 14:23:18

E2041A E2046A

Sensors and Instrumentation

Written examination on theory part 1, 1.5 hp

The 7th of December, HT 2018

All answers to the questions and solutions to the mathematical problems should be written in an "easy to read and easy to follow" fashion. Mention and motivate, if you make an assumption. Try to be precise and coherent in formulating your answers. Irrelevant and/or unnecessarily long text might cost you points. Figures and plots, if needed, should be drawn with proper labels, units and axes.

- Course codes
  - EL041A, EL046A
- Aid:
  - Calculator,
  - If relevant, a dictionary or electronic dictionary between English and the students home language.

- Time: 2 hours.
- Maximum points: 30.
- Minimum points to pass: 15.

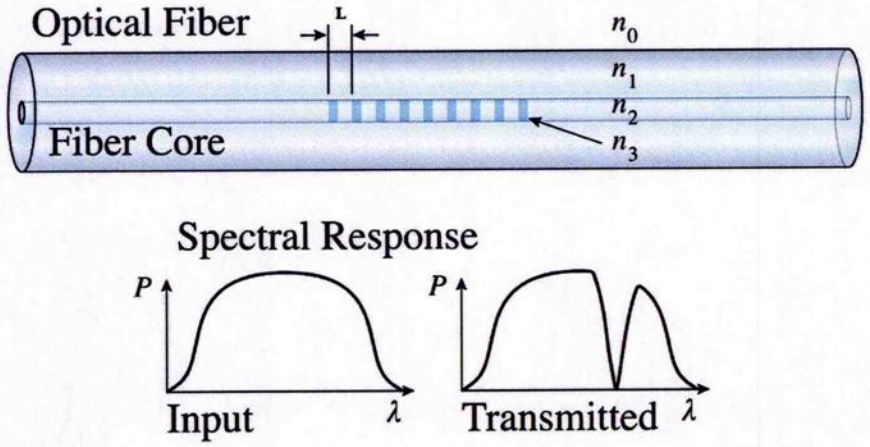
Grading scale:

30	Max
27	A
24	B
21	C
18	D
15	E
14	Fx
0-13	F

Section A: 5 x 3 = 15 points

(1) Sensor characterization is usually described using a graph showing sensor output versus stimulus. Draw such graphs to exemplify the concepts of saturation and of dead band in sensor characteristics.

(2) Below here you see a Fiber Bragg Grating (FBG) sensor, together with its typical spectral response. Why part of the input signal is missing in the transmitted signal? The missing signal depends on which FBG sensor properties?



(3) Briefly describe the piezoelectric, the pyroelectric and the piezoresistive effects.

(4) An sensor for X-ray imaging is used to measure radioactive dose to astronauts on the international space station. Explain how an imaging sensor can be used to distinguish between alfa-, beta- and gamma-contribution in cosmic radiation.

(5) Explain how Eddy currents are utilized in a dual-coil metal detector.

Section B: 10 points

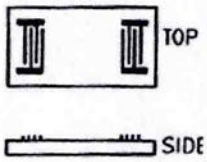
(1) The speed of sound in air is 340 m/s and the measured linar distance between an ultrasonic sensor and an object is 1.2 m. The angle between the incident and the reflected sound wave on the surface of the object is 5°. Calculate the total time for the sound wave to travel from the transmitter of the ultrasonic sensor to the object and then back to the receiver.

3 points

(2) A chemical sensor for gas concentration measurements using surface deposition is designed using an acoustic wave device. The piezoelectric crystal changes its resonant frequency due to perturbation. Consider a device whose reference resonant frequency is 4 MHz. The sensor shows short term fluctuations of 2.0 Hz in pure air. The measured sensitivity of the sensor is reported to be S_m = 14 cm^2/g. Calculate the minimal detectable amount of deposited material for the acoustic wave device. The effective area of the sensor, between the electrodes, is 2 mm x 1.5 mm.

4 points

Help: $\frac{\Delta f}{f} = S_m \Delta m$



(3) What is earth's angular velocity? What is the actual speed due to earth rotation of an object located at the equator.

3 points

Help:
A complete/full rotation is equal to 2π radains Angular velocity radians per time unit. The 1795 French definition of the meter was a $1/10^7$ part of the quadrant along the meridian from the equator to the north pole, i.e that gives the equator perimeter approximately 4 times this value.

Section C: 5 x 1 = 5 points

Find the most correct answer.

(1) An ionic smoke detectors functions by detecting increased absorption of radiation due to smoke in air. The smoke detector contains

(a) A radioactive source emitting beta particles.
(b) A radioactive source emitting alfa particles.
(c) A source of polarized ions.
(d) Both (a) and (c).

(2) When polarized light strikes a non-metallic object, the rejected light usually

(a) Retain its polarization.
(b) Has different polarization angle.
(c) Becomes non-polarized.
(d) None of the above.

(3) Dynamic range of a sensor is expressed

(a) As the difference between the smallest and the largest signals the sensor can measure.
(b) As the sum of the smallest and the largest signals the sensor can measure.
(c) As the ratio between the smallest and the largest signals the sensor can measure.
(d) None of the above.

(4) Metal detectors functions by the use of

(a) Magnetic flux variation measurements.
(b) Eddy current loops in the metal object.
(c) Both (a) and (b).
(d) None of the above.

(5) Heat can not be contained, which means that it flows spontaneously from warmer to cooler part of the system and there is no method known to modern science to stop the heat flow entirely

(a) True
(b) False
(c) Heat flow is mainly a quantum mechanical property that needs relativistic corrections to be understood since the flow approaches the speed of light.