Name:_____

Student ID: _____

Introduction to MEMS

Quiz #4

UCI Fall Quarter 2008

Note to the student: There are several versions of this quiz being used today. Each quiz has the same or similar questions and answers, but in different order. The same answer may be correct on one quiz and incorrect on another. Please BEWARE. If you notice the answer on a neighbor's quiz, it may not be the correct answer for yours.

Please answer questions using the answer sheet at the end of this quiz. For short response questions, you should not need to use more than a few sentences.

Turn in **all** portions of this quiz after finishing. Good luck.

ANSWER KEY

Section 1: Multiple choice

Do not answer in this portion; use the answer sheet at the end of the test. Write your answers clearly. If I can't understand your writing, I have to assume it to be incorrect.

Identify the most correct answer:

1 What was a major innovation for the TI DMD manufacturing process?

(a) Polymer MEMS (b) [Device packaging] (c) CMOS circuits (d) Wafer thinning

2 What makes it difficult to couple optical fibers to photonic devices?

(a) Incompatible materials (b) Electrostatic discharge (c) RF impedance mismatch (d) [Alignment is difficult]

3 What is an erbium doped fiber amplifier (EDFA)?

(a) An optical switch (b) A fiber puller (c) [A fiber laser] (d) An optical filter

4 Which direction does a VCSEL emit light?

(a) VCSEL does not emit light (b) [Out the top] (c) All directions (d) Out the side

5 What is a Mach-Zehnder device used for in optical telecom?

(a) Amplify light (b) Correct polarization (c) [Rapidly modulate light] (d) Filter light

6 Which MEMS device can enable the "all optical network"?

(a) MEMS bolometer (b) [MEMS optical switch] (c) Multimode fiber (d) Diffused waveguides

7 What actuation method does the TI DMD mirror use?

(a) Magnetic (b) [Electrostatic] (c) Thermal (d) Piezoelectric

8 Which light source requires an aspheric lens to correct the light beam?

(a) [Ridge laser diode] (b) VCSEL (c) HeNe laser (d) Arc lamp

9 What is the name of the outermost material of an optical fiber?

(a) Internal tube (b) [Cladding] (c) Core (d) Pipeline

10 Which wavelength light is used in optical telecom?

(a) 2 millimeters (b) 550 nm (c) [1550 nm] (d) 200 nm

11 How is a silicon "V"-groove useful for optical fiber devices?

(a) Makes fiber mirrors | (b) [Makes alignment slot for fiber] | (c) Makes optical polish | (d) Makes excellent filter

12 What is the size of a single TI DMD mirror?

(a) 1.6 mm | (b) [16 microns] | (c) 16 nm | (d) 160 microns

13 Which light detection material has good response over the visible range?

(a) [Silicon] | (b) InGaAs | (c) Gold | (d) Polymer

14 What is dense wavelength division multiplexing (DWDM)?

(a) A way of imaging multiple colors | (b) [A method of putting more data in an optical fiber] | (c) A MEMS spectrometer | (d) A way of changing the wavelength of light

15 What principle makes optical fibers useful for carrying light?

(a) Rayleigh scattering | (b) Quantum emission | (c) [Total internal reflection] | (d) Gold reflectivity

16 Which is an advantage for RF MEMS switches?

(a) High power capability | (b) High speed | (c) Low voltage operation | (d) [Low loss]

17 What does the RF MEMS switch do?

(a) [Turn on or off an RF line] | (b) Change RF polarization | (c) Make oscillations | (d) Radiate RF signals

18 Which light detection material has good response over the IR range?

(a) Polymer | (b) Silicon | (c) [InGaAs] | (d) Gold

19 Why is IR light used for telecom applications?

(a) Cheaper optics | (b) [Low attenuation in glass] | (c) Faster light speed | (d) Easier alignment

20 Which is a major cost problem for optical telecom device manufacturing?

(a) Complexity | (b) Lifetime | (c) Performance | (d) [Packaging]

21 What is a "grating light valve"?

(a) An optical fiber package | (b) [A MEMS-based projector] | (c) A light detector | (d) A spectrometer

22 Why is a "push-pull" configuration beneficial in a Mach-Zehnder device?

(a) Easier to manufacture (b) [Lower voltage required] (c) Bi-directional modulation (d) Easier to package

23 An incandescent lamp typically produces what kind of light?

(a) [Broadband light] (b) Narrowband light (c) X-rays (d) Coherent light

24 Which device can image (detect) long wavelength IR light?

(a) [Bolometer] (b) TI DMD array (c) Memory chip (d) CCD array

25 What material is a good material to build an RF MEMS switch?

(a) Glass (b) Silicon (c) [Gold] (d) SU-8

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Section 2: Multiple choice answers

Please denote your answers by filling in the appropriate diamond below. Make your answer clear; completely erase any unintended marks. Check the question number carefully.

1) ◇A ◇B ◇C ◇D
2) ◇A ◇B ◇C ◇D
3) ◇A ◇B ◇C ◇D
4) ◇A ◇B ◇C ◇D
5) ◇A ◇B ◇C ◇D
6) ◇A ◇B ◇C ◇D
7) ◇A ◇B ◇C ◇D
8) ◇A ◇B ◇C ◇D
9) ◇A ◇B ◇C ◇D
10) ◇A ◇B ◇C ◇D
11) ◇A ◇B ◇C ◇D
12) ◇A ◇B ◇C ◇D
13) ◇A ◇B ◇C ◇D
14) ◇A ◇B ◇C ◇D
15) ◇A ◇B ◇C ◇D
16) ◇A ◇B ◇C ◇D
17) ◇A ◇B ◇C ◇D
18) ◇A ◇B ◇C ◇D
19) ◇A ◇B ◇C ◇D
20) ◇A ◇B ◇C ◇D
21) ◇A ◇B ◇C ◇D
22) ◇A ◇B ◇C ◇D
23) ◇A ◇B ◇C ◇D
24) ◇A ◇B ◇C ◇D
25) ◇A ◇B ◇C ◇D

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Section 3: Short response

Answer each question in one or two sentences. Write your answers clearly and be brief. If I can't understand your writing, I have to assume it to be incorrect.

26 Draw/describe how an capacitive RF MEMS switch works.

Should show a membrane that is supported over a conductive trace. Should say something about a voltage used to attract the membrane down.

27 Describe why single mode fiber is better for long range communication than multi-mode fiber.

All the light in a single mode fiber travels the same distance and so arrives at the destination at the same time. Multimode fiber allows multiple path lengths and so allows broadening of the signal.

28 What is lithium niobate and why is it important?

It is an electro-optical material that changes its wavelength in the presence of an electric field. It is used for almost all optical modulators in telecom.

29 What is dense wavelength division multiplexing (DWDM)?

Putting multiple channels on single fiber by using a different wavelength of light for each channel.

30 Draw/describe how a Mach-Zehnder device works.

Should show single path splitting into two optical paths with one path having a electrodes that phase shift the light. Then the paths should recombine to interfere the light.

31 What is a Bragg fiber grating and how does it work?

It is a fiber containing hundreds or thousands of reflecting bands that produces a very good light filter. It is used for filtering light in optical fibers.

32 Describe how the Texas Instruments DMD creates gray images.

High speed switching of mirror at a given duty cycle gives appearance of gray.

33 What is the purpose of a monitor photodiode in a laser diode package?

Monitor light intensity from backside of laser diode to correct for intensity fluctuations.

34 What advantage would an all-optical network have?

All optical networks don't have to convert from optical to electrical back to optical (OE-EO) which is very expensive.

35 How does the EDFA enable multiple wavelengths of light to be transmitted across the ocean?

The EDFA eliminates the need for optical/electrical-electrical/optical repeaters, greatly simplifying the transmission of light, especially multiple wavelengths, across long distances.