

國立清華大學命題紙

99 學年度 奈米工程與微系統研究所 碩士班入學考試

科目 科技 英文 科目代碼 1802 共 7 頁，第 1 頁 *請在【答案卷卡】作答

(100 points in total)

Part I. There are 65 problems in this part. You have to choose the best answer, marked A, B, C, or D, to each question and write down your answer in the associated blank. You will have 1 point for each correct answer and there is no penalty with wrong answers.

1. [] ----- at the turn of the century, the Minnesota State Capitol building is made of white granite and marble. (A) Erected (B) Was erected (C) To erect it (D) Erecting it
2. [] A stream of volcanic lava flows differently, ----- on the sort of ground it flows over. (A) to depend (B) depending (C) that dependent (D) when it depended
3. [] Next semester, NEMS 5800 ----- at 9:00 a.m. (A) starting (B) started (C) starts (D) has started
4. [] ----- large amounts of vitamin E found in green leaves, such as lettuce, and in cereals, especially in wheat germ. (A) The (B) They have (C) There are (D) Because of
5. [] Kay ----- really sick. She always comes to class, even when she has a slight cold. (A) could be (B) must be (C) is (D) should be
6. [] A popular belief ----- radio and television have homogenized the language of the world. (A) states that (B) that is stated (C) that states (D) stating that
7. [] The astronomical unit is the average distance of the Earth from the Sun ----- is the standard of distances in the Solar System. (A) and (B) also (C) in addition (D) because
8. [] The lenses in an optical microscope bend the light passing through a specimen to form an image of that specimen that is much larger ----- actually viewed. (A) than it (B) than the one (C) one than (D) than one which
9. [] Because air is highly compressible, ----- to define a clear upper boundary of the atmosphere. (A) it is impossible (B) impossible is (C) so the impossible (D) is the impossibility
10. [] BASIC, the acronym for Beginner's All-purpose Symbolic Instruction Code, is a high-level computer programming language ----- . (A) learning relatively simple (B) related it simply to learning (C) simple and relative to learn (D) that is relatively simple to learn
11. [] Mila ate a huge lunch, and she usually doesn't eat much. She ----- hungry. (A) must have been (B) must be (C) must have being (D) doesn't have to be
12. [] "I ----- a party during spring break. Would you like to come?" (A) am having (B) will be having (C) had (D) be going to have
13. [] Not only ----- as a cooked dish the world over, but it is also used as the base of many other foods, condiments, and even beverages. (A) eating rice (B) rice is eaten (C) people eat rice (D) is rice eaten
14. [] When Mary was pregnant, she thought she ----- a girl, but she had a boy. (A) is going to have (B) will have (C) was going to had (D) would have
15. [] The Earth has a tremendous amount of water, but ----- in the oceans. (A) almost all of it is (B) it is almost all of (C) is of it almost all (D) all is of it almost

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16. [] Direct information on the chemical composition of the Moon became available in 1969 ----- of the first Apollo mission to land on the Moon. (A) with the return (B) returning (C) when returned (D) and the return
17. [] ----- completely harmless to the environment is very difficult and usually economically unsound. (A) Cleaning products that (B) Cleaning products are (C) Cleaning products are made (D) Making a cleaning product
18. [] ----- classified as a carnivore, the North American grizzly bear eats berries and even grass. (A) Just as (B) Because of (C) Although (D) Either
19. [] No only ----- much bigger than any planet, but unlike the planets, it consists completely of gaseous material. (A) the Sun is (B) the Sun, which is (C) is the Sun (D) that the Sun
20. [] ----- usually thought to end in northern New Mexico, the Rocky Mountains really extend southward to the frontier of Mexico. (A) Despite (B) To be (C) While (D) However
21. [] ----- a major role in future planetary exploration. (A) Robots will surely play (B) Robots, which will surely play (C) Because robots will surely be playing (D) Surely robots, which will be playing
22. [] Experiments related to the sense of force and displacement are more easily ----- than those related to measurement of stress and strain. (A) sets up those (B) set up (C) setting up (D) setting them up
23. [] The Nobel Prize has been ----- in Physics, Chemistry, Physiology or Medicine, Literature, and Peace worldwide for more than hundred years. (A) the most prestigious award (B) the award most prestigious that (C) most prestigious award (D) a prestigious award that most
24. [] Not only ----- all the positive charge of an atom, but it is also the site of the weight of every atom. (A) holds the nucleus (B) the nucleus does hold (C) the nucleus holding (D) does the nucleus hold
25. [] "Hong long has Helen lived in Hsinchu?" "She's lived here ----- she started her Master's at NTHU." (A) because (B) since (C) when (D) for
26. [] Unlike the owl, bats cannot see very well, but they do have ----- . (A) it hears very well (B) very good to hear (C) hearing very well (D) very good hearing
27. [] ----- touching in O. Hery's stories is the gallantry with which ordinary people struggle to maintain their dignity. (A) Most is (B) It mostly is (C) It is most (D) What is most
28. [] The face of the Moon is changed by collisions with meteoroids, ----- new craters to appear. (A) cause (B) causing (C) caused (D) have cause
29. [] When my parents ----- for a visit tomorrow, they will see our new apartment for the first time. (A) will arrive (B) arrived (C) will have arrived (D) arrive
30. [] Anna used to take the bus to her job in NTHU to save gas. But on days when she was late, she ----- her car. (A) would drive (B) always driving (C) would be driving (D) will drive

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31. [] Social scientists believe that ----- from sounds such as grunts and barks made by early ancestors of human beings. (A) the very slow development of language (B) language developed very slowly (C) language, which was very slow to develop (D) language, very slowly developing
32. [] ----- substances include various forms of silica, pumice, and emery. (A) Natural abrasives occur (B) Abrasion occurs in natural (C) Naturally occurring abrasive (D) A natural occurrence of abrasion
33. [] ----- is the upper part of their long, thin legs allow deer to run swiftly and jump far. (A) Muscles are powerful (B) There are powerful muscles (C) The powerful muscles that (D) Powerful muscles
34. [] Before John ----- to Taiwan, his cousin had lived here for several years. (A) coming (B) comes (C) had come (D) came
35. [] Mike ----- dinner when the phone rang and he answered it. (A) had been cooking (B) is cooking (C) has cooked (D) cooked
36. [] Many birds have feathers ----- with their surroundings. (A) colors blend (B) that colors to blend (C) whose colors blend (D) of which the colors that blend
37. [] Mosaic is the art of closely setting small, colored pieces, such as stone or glass, into a surface ----- (A) and create a decorative design (B) and a decorative design creates (C) to create a decorative design (D) that a decorative design is created
38. [] ----- that distinguish human beings from other primates are related to the ability of people to stand upright and walk on two legs. (A) Many of the physical characteristics (B) Of the many physical characteristics (C) The physical characteristics are many (D) There are many physical characteristics
39. [] Geophysicists have collaborated with archaeologists and anthropologists to study the magnetic properties of pottery and fireplaces at sites ----- by early humans. (A) occupied (B) occupying (C) which occupy (D) were occupied
40. [] John is still in his office. He ----- late again. (A) must have worked (B) ought to be working (C) must be working (D) ought to work
41. [] You ----- do this assignment. It's optional. (A) haven't to (B) ought to (C) don't have to (D) have to
42. [] Although Canada's Parliament can neither administer or enforce laws ----- initiate policy, it does have the power to make laws and vote the allocation of funds. (A) not (B) nor (C) and (D) either
43. [] "I stayed up until 3 a.m. last night to study for the midterm of Micro & Nano Technology." "You ----- tired!" (A) will be (B) must be (C) could be (D) might be
44. [] First designated in 1970, Earth Day has become an annual international event ----- concerns about environmental issues such as pollution. (A) dedicated to raising (B) dedicated raising (C) dedicates to raise (D) that dedicates to raising
45. [] Why are you late? You ----- be here an hour ago. (A) were allowed (B) used to (C) were supposed to (D) must have been

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46. [] Fossils, the preserved remains or traces of animals, plants, and other organisms from the remote past, indicate ----- existing in the past have become extinct. (A) many species of organisms are (B) there are many organisms (C) that many species of organisms (D) many species of organisms that
47. [] ----- lay eggs, but some give birth to live young. (A) Although most sharks (B) Most sharks (C) Despite most sharks (D) Most sharks that
48. [] By means of various types of sensors, ----- simulate most of the environmental variations to which a micro system is subjected. (A) the ability of MEMS engineers to (B) MEMS engineers, being able to (C) which MEMS engineers can (D) MEMS engineers can
49. [] ----- planes in flight between airports, air traffic control systems rely heavily on radar. (A) Of tracking (B) Track of (C) To Track (D) Tracked
50. [] The operating principles of the telecommunication are ----- they were in the nineteenth century. (A) the same today (B) the same as today (C) the same today as (D) today what the same
51. [] Everyone of us ----- for home at this time tomorrow. (A) left (B) to be leaving (C) have left (D) will be leaving
52. [] The Pistons ----- the championship in April because they have the best record in the NBA. (A) will going to win (B) are wining (C) are going to win (D) winning
53. [] There are two machines in the corner; one is an automatic coin changer and ----- a vending machine. (A) one (B) other (C) the other (D) another
54. [] Let her ----- her own way. (A) had (B) have (C) has (D) has had
55. [] ----- in cases where special oxidants are used, fires are the result of a fuel rapidly combining with the oxygen in the air. (A) Even though (B) There are (C) Except (D) How
56. [] The daytime ----- bright because the Earth's atmosphere scatters sunlight. (A) has a sky (B) while sky (C) for the sky (D) sky is
57. [] The development of synthetic fibers led to the production of new types of fabrics ----- more durable and easier to care for. (A) that were (B) that they were (C) and were (D) were
58. [] Pure iron cannot be hardened by temperature treatment, as -----, because iron lacks the necessary carbon. (A) so can steel (B) with steel can (C) can steel (D) steel it can
59. [] Airsickness is produced by a disturbance of the inner ear, ----- psychogenic factors, such as fear, also play a part. (A) nor (B) neither (C) in spite of (D) although
60. [] The world's deepest cave is almost three times as deep ----- . (A) as the Empire State Building is high (B) is higher than the Empire State Building (C) that the Empire State Building is higher (D) and the Empire State Building's height

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61. [] In 1880, ----- that the piezoelectric effect occurs when the charge balance within the crystal lattice of a material is disturbed. (A) the discovery (B) it was discovered (C) with the discovery (D) if it was discovered
62. [] Although beavers, known for building dams, rarely remain submerged for more than two minutes, they can stay underwater ----- fifteen minutes before having to surface for air. (A) as long as (B) as long (C) so long that (D) so long
63. [] Tiffany inherited a lot of money, so now she ----- work. (A) can't (B) isn't used to (C) mustn't (D) doesn't have to
64. [] You are tired. You ----- take a rest before we go out. (A) might have wanted to (B) might be wanting to (C) want to (D) might want to
65. [] "Where is the new MEMS textbook you bought yesterday?" "The teacher said we didn't need it, so I ----- to the store." (A) return (B) have been returning (C) returned (D) did return

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Part II. Answer problems 66-75 based on the following excerpts of a conference paper. You will have 2 points in each problem. There is no minus point for problems in this part so try your best to have the correct answers.

This technical paper was extracted from 2010 IEEE MEMS Conference. Source: Khalil Najafi's group at University of Michigan.

This paper describes an all-electrical individually-addressable micro-hydraulic actuator array that produces high displacement and force by utilizing hydraulic amplification and electrostatic control, offering a considerable improvement in fabrication technique and performance over the recently-introduced micro-piston hydraulic actuator array [1,2]. The fabricated micro system consists of 3×3 and 4×4 arrays of actuator cells. A curved electrode capacitive actuator with a diameter of 2236 μm driven at 200 V produces 30.0 μm deflection on the front side at 14.4 kPa of pressure which corresponds to 11.3 mN force generated by the capacitive actuator on the back side. Actuation occurs from DC to 15 Hz.

High-force, large-deflection actuators are critical for devices such as valves and pumps used in microfluidic systems, for surface bump manipulation in tactile displays, and micro-airfoil control. Table 1 lists potential actuation methods.

Table 1: Comparison of several actuation methods.

	E.S.	Hydra.	Piezo.	Pneu.	E.M.
Force	Low	High	High	High	High
Deflection	Small	Large	Small	Large	Large
Fabrication & Materials	Easy	Difficult	Difficult	Difficult	Difficult
Power	Low	High	Low	High	High
Control	Easy	Easy	Medium	Easy	Hard
Speed	Fast	Medium	Fast	Slow	Fast

* E.S.=electrostatic; Hydra=hydraulic; Piezo=piezoelectric; Pneu=Pneumatic; E.M.=electro-magnetic

Electrostatic actuation cannot provide the high forces (~10-100 mN) required for many applications. Techniques capable of high force suffer from control difficulties (E.M.) or are limited to small deflections (Piezo.). This raises a need for a new class of actuators that offers controllable and high force actuation which can be delivered across a large displacement range. Our approach is to assist electrostatic actuation with hydraulic amplification. The E.S. mechanism allows for low power actuation and excellent control, while the hydraulic system provides large deflection and high force actuation.

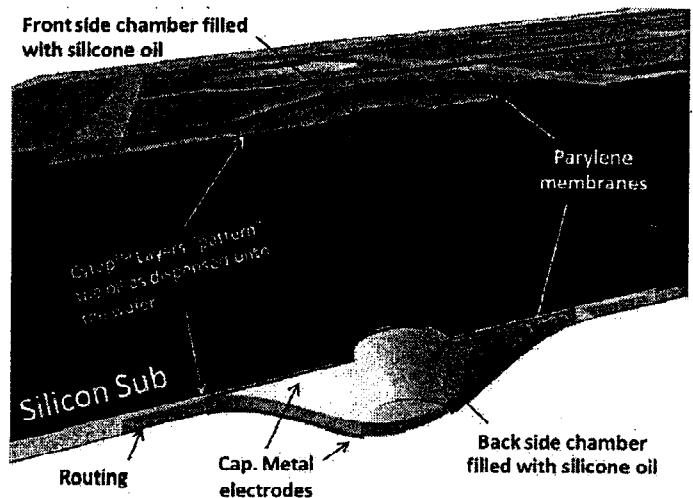
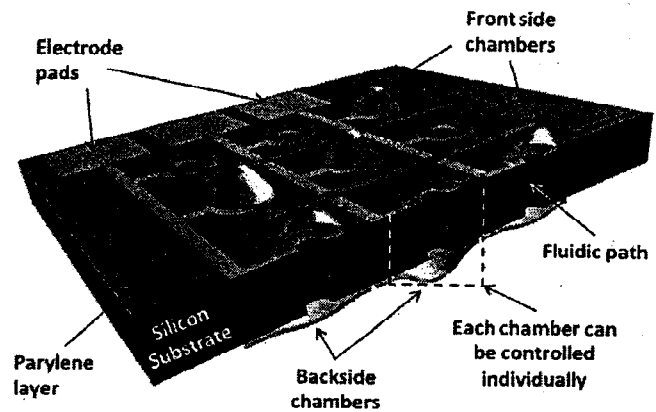


Figure 1: Schematic drawing of an array of micro-hydraulic cells made using direct deposition of Parylene over silicone fluid. The bottom sketch shows a close up of one of the cells.

The concept of a new technology which combines electrostatic and micro-hydraulic actuation to obtain large-force, large deflection, and low-power actuation is shown in Figure 1. This technology is referred to as electrostatic micro-hydraulic actuation or EMA. Each actuator cell consists of two Parylene membranes that cap two chambers on opposite sides of a wafer. The top and bottom chambers are connected with a channel etched through the wafer. Capacitive metal electrodes on the silicon surface and membrane allow electrostatic actuation (or sensing) on the back and/or front of the wafer. EMA is able to produce higher displacement and larger force than typical electrostatic actuators by filling the chambers and wafer-through channel with a non-conducting liquid which acts both as a hydraulic fluid and as the capacitor dielectric. As electrostatic actuation pulls down one flexible membrane, the liquid is pushed into the opposite chamber, causing its membrane to be deflected out of plane.

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66. [] What is NOT one of the major improvements for the array developed in this paper compared to previously fabricated micro-piston hydraulic actuator array? (A) larger force output (B) better noise rejection (C) higher displacement (D) larger deflection
67. [] What is the main bottleneck for actuators using pure electrostatic approach in many applications? (A) low operational speed (B) high power consumption (C) low output force (D) smaller bandwidth
68. [] What is the major disadvantage when electro-magnetic actuators are utilized? (A) Not easy to control (B) Cannot produce high force output (C) Cannot generate large deflection (D) Not easy to achieve high speed
69. [] What is the major issue of using Piezoelectric transducers as actuators? (A) Control (B) Power consumption (C) Force output (D) Deflection
70. [] This new class of actuators developed in this paper brings ----- and hydraulic amplification together to provide controllable and high force actuation. (A) thermal actuation (B) electro-magnetic actuation (C) piezoelectric actuation (D) electrostatic actuation
71. [] What kind of devices is invented in this paper? (A) Micro-piston hydraulic actuators (B) Electrostatic micro-hydraulic actuators (C) Piezoelectric actuators (D) Electro-magnetic actuators
72. [] What kind of material did the author use to seal the chambers of the wafer in Figure 1? (A) Polyimide (B) PDMS (C) Parylene (D) Glass
73. [] What is the purpose of metal electrodes on the silicon surface shown in Figure 1? (A) Provide electrostatic actuation (B) Seal the chambers (C) Compensate the residual stress of the membrane (D) Filling the chambers
74. [] The liquid filling the chambers and wafer-through channel does NOT serve the purpose of -----? (A) capacitive dielectric (B) hydraulic fluid (C) membrane-deformed driver (D) device power source
75. [] The actuator arrays in this paper can be operated at the frequency of ----- . (A) 10Hz (B) 100Hz (C) 1kHz (D) 1 MHz

Part III. Write two or three paragraphs (three to five sentences per paragraph) addressing what you think is necessary for a successful graduate study and what your future career goals are. You will have 15 points if you get full credits.