Cairo University
Electronics and Communications Department
Dr. Hossam A. H. Fahmy

Technical Language
MSc exam, May 2008
Three hours

This exam focuses on your abilities to read and write effectively in technical English. It consists of two parts.

1 Correct the following sentences by choosing the suitable words

Please write the number and the correct choice only.

- The charity will **(1: except, accept)** used shoes, **(2: except, accept)** those that have holes in them.
- He plays handball to **(3: affect, effect)** his health, but the social **(4: affect, effect)** is also positive.
- The critic gave me a **(5: compliment, complement)** when he wrote that my art was a **(6: compliment, complement)** to the existing exhibit.
- To show **(7: off, of)** his great ability to **(8: lead, led)**, he **(9: lead, led)** them on a hike using a map that he drew himself.
- **(10: Lead, Led, Lid)** is an important **(11: constituent, constituant)** in many industrial products.
- I would **(12: advise, advice)** you to only take **(13: advise, advice)** from someone who understands your problem.
- Since I already **(14: choose, chose)** the bunk bed by the window, you can **(15: choose, chose)** from the three bunk beds in the middle of the cabin.
- I bought these fruits from the nearby **(16: product, produce)** **(17: shop, chop)**.
- If you visit the **(18: desert, dessert)** in the hot summer, you might enjoy ice cream for a cool **(19: desert, dessert)**.
- **(20: Every day, Everyday)**, he did all of his **(21: every day, everyday)** chores before one of his weekly chores.
- I need to study for the physics and the mathematics exams but I cannot start in the **(22: later, latter)** till **(23: later, latter)** today after I get the books back from my friend.
- She leaned **(24: foreword, forward)** in her chair to read the highly interesting **(25: foreword, forward)** of the book.

- When the **(26: lightening, lightning)** flashed across the sky, he dropped his books in surprise, **(27: lightening, lightning)** his load.
- She knew she had to fix the **(28: lose, loose)** **(29: button, baton)** on her jacket or she would **(30: lose, loose)** it.

2 Academic writing

Please read the following articles then write *a single article* about water technologies. I hope that this effort will help you in your future research careers. In your writing, please remember the following issues.

- Your work should be a coherent article with an introduction, body, and conclusion not just a list of unrelated points!
- If your article is divided into sections and subsections then those divisions should have informative titles and be numbered in sequence.
- Your article must not plagiarize! Clearly credit the ideas to their original authors and cite the provided articles as your references. You may cite other references as well obviously.
- The reference list should appear at the end of your article ordered alphabetically by the last name of the first author.
- Your article must address at least the following points and is expected to discuss other ideas either from the provided articles or from your own background information:
  1. The situations in Egypt and Australia. The specific needs in each case and the proposed solutions.
  2. The basic science behind the different technologies.
  3. The environmental impact of each technology.
  4. The economics of the solutions including water transportation, scalability, and present market availability.
  5. The proposed priorities for the use of water in Egypt and their relation to national security.
- Your article should have neither spelling nor grammar mistakes.

2.1 Australia Turns to Desalination Amid Water Shortage

By Michael Sullivan on *National Public Radio, USA* Monday 18 June 2007.

Look at the grass courts at Perth's Peppermint Grove Tennis Club, and it's difficult to believe the talk about drought and the possibility that this west Australian coastal city will run out of water.

Beyond the fence, sailboats and kayaks bob in the Swan River, a thick ribbon of blue that winds through a city bordered on the west by the Indian Ocean. It is a city where water seems to be everywhere. But Perth is facing a serious water shortage.

Over the past 10 years or so, the city has seen a 21 percent decline in rainfall, but the stream flow into dams — the actual amount running into storage — dropped about 65 percent, according to Malcolm Turnbull, Australia's minister for the environment and water resources.

"We've seen similar declines in stream flow, though not quite so dramatic across southern Australia," he says.

Turnbull calls Perth the "canary in the climate change coalmine," a city scrambling to find other sources of water for a growing population. The city is riding a wave of economic prosperity fueled by China's insatiable appetite for Western Australia's natural resources.

Perth, with a population of about 1.7 million, is growing 3 percent a year — about 750 families a week move to the city, says Gary Crisp of the Western Australia Water Corp.

"We need more water," he says. "We're absolutely running out."

The Water Corp. turned to the nearby Indian Ocean to help solve the problem.

The Kwinana Desalination Plant south of the city opened two months ago. The facility, the first of its kind in Australia, covers just a few acres in an industrial park next to the ocean.

The water is sucked in through a pipe about 650 feet offshore in Cockburn Sound, at a rate of about 0.1 meters per second, says project manager Simon McKay.

That is slow enough to let the fish escape, but fast enough to provide nearly 40 million gallons of drinking water each day — roughly 20 percent of Perth's daily consumption. That makes the plant the single largest source of water for the city.

McKay says it doesn't take very long for the seawater to be ready for the tap — about a half-hour from the time it comes out of the ocean until it's processed and distributed.

Desalination plants have been around in places like the Middle East for decades. But they've always been expensive to build and expensive to run. New technology has made them cheaper and more efficient, but they still consume a large amount of energy.

Environmentalists in Perth balked at the idea of using coal-fired plants to provide power for the one here, forcing the Water Corp. to find a non-polluting, renewable alternative. It found that alternative — wind energy — near the town of Cervantes, a three-hour drive north of Perth.

The Emu Downs Wind Farm houses 48 wind turbines, each as high as a 15-story building.

Kerry Roberts, the facility's general manager, says Emu Downs is among the top 10 or 20 sites for this type of energy alternative in Australia.

"If you look at the combined output of the wind farm at maximum wind speeds — 24 to 28 miles per hour — you're looking at an output of close to 80 megawatts," Roberts explains. That's enough power to run Perth's desalination plant, 160 miles to the south.

This successful marriage of renewable technology and necessity has Crisp, of the Western Australia Water Corp., thinking big: "I predict that desalination will account for at least half of Perth's water in the next 30 years."

Other water-stressed seaside cities in Australia are taking a serious look at desalination, as traditional water sources dry up because of lack of rain. Sydney, on Australia's southeast coast, is expected to commission a plant even larger than Perth's in the next few months.

Nonetheless, the desalination boom extends far beyond Australia's shores. McKay — the man in charge of getting Perth's plant running — will soon be off to Muscat, Oman, to build another. His company's order book is filling up quickly, he says, and he doesn't expect that to change in his lifetime. Neither does Crisp.

"The world is going reverse osmosis," he says, naming projects proposed from California to Spain.

"Desalination is here to stay, and, provided energy is not taken out of normal coal-burning systems, I believe it's the solution for the semiarid parts of the world," Crisp adds.

2.2 Cheap Drinking Water from the Ocean

By Aditi Risbud in *Technology Review—Published by MIT* Monday 12 June 2006.

A water desalination system using carbon nanotube-based membranes could significantly reduce the cost of purifying water from the ocean. The technology could potentially provide a solution to water shortages both in the United States, where populations are expected to soar in areas with few freshwater sources, and worldwide, where a lack of clean water is a major cause of disease.

The new membranes, developed by researchers at Lawrence Livermore National Laboratory (LLNL), could reduce the cost of desalination by 75 percent, compared to reverse osmosis methods used today, the researchers say. The membranes, which sort molecules by size and with electrostatic forces, could also separate various gases, perhaps leading to economical ways to capture carbon dioxide emitted from power plants, to prevent it from entering the atmosphere.

The carbon nanotubes used by the researchers are sheets of carbon atoms rolled so tightly that only seven water molecules can fit across their diameter. Their small size makes them good candidates for separating molecules. And, despite their diminutive dimensions, these nanopores allow water to flow at the same rate as pores considerably larger, reducing the amount of pressure needed to force water through, and potentially saving energy and costs compared to reverse osmosis using conventional membranes.

Indeed, the LLNL team measures water flow rates up to 10 000 times faster than would be predicted by classical equations, which suggest that flow rates through a pore will slow to a crawl as the diameter drops. “It’s something that is quite counter-intuitive,” says LLNL chemical engineer Jason Holt, whose findings appeared in the 19 May issue of Science. “As you shrink the pore size, there is a huge enhancement in flow rate.”

The surprising results might be due to the smooth interior of the nanotubes, or to physics at this small scale — more research is needed to understand the mechanisms involved. “In some physical systems the underlying assumptions are not valid at these smaller length scales,” says Rod Ruoff, a physical chemist and professor of mechanical engineering at Northwestern University (who was not involved with the work).

To make the membranes, the researchers started with a silicon wafer about the size of a quarter, coated with a metal nanoparticle catalyst for growing carbon nanotubes. Holt says the small particles allow the nanotubes to grow “like blades of grass — vertically aligned and closely packed.” Once grown, the gaps between the nanotubes are filled with a ceramic material, silicon nitride, which provides stability and helps the membrane adhere to the underlying silicon wafer. The field of nanotubes functions as an array of pores, allowing water and certain gases through, while keeping larger molecules and clusters of molecules at bay.

Holt estimates that these membranes could be brought to market within the next five to ten years. “The challenge is to scale up so we can produce usable amounts of these membrane materials for desalination, or gas separation, the other high-impact application for these membranes,” he says, adding that the fabrication process is “inherently scalable.”

Eventually, the membranes could be adapted for a variety of applications, ranging from pharmaceuticals to the food industry, where they could be used to separate sugars, for example, says co-author Olgica Bakajin, a physicist at LLNL. “Practically, the next step is figuring out how to take a general concept and modify it to a specific application,” Bakajin says.

“There are many studies that one can imagine to build upon this study,” says Northwestern’s Ruoff. “Our understanding of molecular processes will be helped by experiments of this type. There are interesting possibilities for nanofluidic applications, such as in nanoelectromechanical systems and in ‘smart’ switching [on and off] of the flow through such small channels.”

2.3 New Water Technology Headed for Parched Places

By Sarah Adee in *IEEE Spectrum* April 2008.

Next month an Australian-led coalition is expected to unveil a project to build experimental waterpurification reactors in drought-plagued northeastern Australia. Parched cities in Queensland and New South Wales are turning to capacitive deionization (CDI), an electric field-based water desalination technology that could make inland water desalination much more affordable. CDI has long been stuck in laboratories and ignored by municipalities, which have preferred a mechanical method called reverse osmosis. But worsening inland droughts, massive private funding, and an international research effort are giving the alternative desalination technology its big break. CDI's backers say it will be on the market in 2009.

The dominant desalination technologies rely on membranes that frequently need replacement and cleaning. The most common, reverse osmosis, filters impurities by pushing pressurized water through a membrane. Another uses an electric field to drive the ions across a membrane.

CDI, in contrast, needs no membrane. In water, salts are dissolved as positively charged and negatively charged ions. CDI streams water between pairs of two oppositely charged porous electrodes. The negative ions drift into the pores of the positive electrodes and the positive ions drift to the negative, leaving pure, deionized water. Once the electrodes are "full," the reactor is stopped. The polarity of the electrodes is then reversed, and the ions are repelled. The ions are then flushed out of the reactor, flowing into a waste stream of supersalty brine.

Hoping to increase the electrodes' ion capacity and thus improve CDI's economics, Lawrence Livermore National Laboratory built the electrodes out of conductive carbon aerogel, a material with a surface area about 260 million times its volume (a grape-size piece has the surface area of two basketball courts). The aerogel's pores trapped huge numbers of ions before they were saturated, but they were also prone to clogging up with bacteria, which feed on organic particles in the water.

Bob Campbell, CEO of California-based Campbell Applied Physics, which is managing the Australia project, tackled the problem. With funding from Malta-based Water Resources International, Campbell worked with four U.S. Department of Energy national laboratories, among them Lawrence Livermore. The team developed a proprietary ozone technology that kills the bacteria before they can fill the aerogel's pores, says Lawrence Livermore technologist Bill Daily, who is developing the deionization reactors for the Australia project.

Northeastern Australia will be the first to commercialize CDI because of the proximity of parched cities to coal-bed gas mines, where pressurized underground water is used to release the trapped gas. The by-product is water that, though ample, is too brackish even for most agricultural uses. Many in the water industry have predicted that Australian demand for waterpurification technology will spike as the mining industry taps the deep coal deposits in Australia's largest aquifer.

The reason reverse osmosis has dominated the market, and hence discouraged research into other methods, is that municipalities wanting water desalination have usually been coastal: huge desalination plants are built on shorelines in the Middle East, China, California, and Texas.

Where the water's salt content is high — it's about 32 000 milligrams per liter in ocean water — reverse osmosis is efficient and cost-effective. But for inland brackish waters, in which there might be 800 to 3500 mg/L of salt, CDI requires less energy, says Frost & Sullivan analyst Afamia Elnakat.

Until recently, opportunities for inland desalination were scarce because, as Elnakat says, "the water problem just hasn't hit anyone in the pocket yet." But inland droughts are starting to become ruinous. In the past two years, water levels in northeastern Australia have dropped to one quarter of their normal depth, causing barley and wheat production to plummet (and contributing to the country's decision to sign onto the

Kyoto climate agreement). Similar long-term droughts have laid waste to water supplies in China and in the southwestern United States.

In these situations, CDI is a clear winner, argues Campbell. Its main efficiency advantage versus reverse osmosis is that it doesn't need pressurized water. CDI can also save power by allowing for "dial-in" ion concentrations: for medically pure water, for example, the reactors can remove all dissolved ions; but for agriculture the water can be somewhat saltier. The fewer ions that need to be removed, the longer the reactors can go between rinses.

And deionization might play a role in seawater desalination too. The World Health Organization warns that the natural boron content in seawater has been linked to developmental and reproductive disorders. Boron ions can slip through reverse osmosis systems. Campbell says that CDI can be a postosmosis polishing step to filter the boron.

2.4 Water resource planning in Egypt

By Martin Hvidt in *The Middle Eastern Environment*: Selected Papers of the 1995 Conference of the British Society for Middle Eastern Studies.

2.4.1 Introduction

Water resources in Egypt are becoming scarce. Surface-water resources originating from the Nile are now fully exploited, while groundwater sources are being brought into full production. Egypt is facing increasing water needs, demanded by a rapidly growing population, by increased urbanisation, by higher standards of living and by an agricultural policy which emphasises expanded production in order to feed the growing population. The population is currently increasing by more than one million people a year. With a population of approximately 55 million in 1994, Egypt is expected to see an increase to some 63 million by the year 2000, and 86 million by 2025.

Improved planning and management procedures to appropriate, allocate and use water are key measures generally prescribed to make the optimum use of available water. As Falkenmark notes, the main constraint for most countries, at medium term, is the capability to develop a sophisticated and far-sighted water-management strategy, along with the legislation and administration necessary to support them. Dr. Abu-Zeid, chairman of Egypt's Water Research Centre points out that "satisfying future demands in Egypt depends on better utilisation and efficient use of present water resources. Optimal water management is an essential prerequisite for sustainable development of Egypt." The future looks bleak if Egypt does not succeed in formulating and implementing a water policy which can match the limited freshwater supply with the increasing demand. The per capita water resources is expected to drop from a current value of about 922 m^3 per year (1990) to about 337 m^3 per year in 2025. And, if the present management practices and cropping patterns prevail, this could mean that up to 60 per cent of the agricultural land will not be irrigated.

This paper analyses Egypt's water policy planning and proposes to highlight the characteristics of this planning effort. To that end, the paper examines the objectives along with the means applied to reach those objectives and it also looks at problems and constraints of a technical, administrative and financial nature encountered in the planning process. Particular emphasis is placed on the functioning of the administrative framework established to undertake this planning effort. Such an analysis is worthwhile because knowledge of Egyptian water resource planning is presently very limited and largely undocumented. The conclusions resulting from this exercise are thus of a preliminary nature. The sources for this paper are the available documentation and the author's own experience gained from research carried out in Egypt in relation to implementation of the Irrigation Improvement Project.

... [the body of the paper is skipped] ...

2.4.2 Conclusion

This paper has focused on the planning of water resources in Egypt. It represents an attempt to collect the scattered and fragmented knowledge about the subject, in order to highlight major characteristics of the planning process. Egyptian water resource planning is given the task of satisfying the ever-increasing water demands which are dictated by a rapidly growing population, increased urbanisation, higher standards of living, and an agricultural policy which emphasises expanded production in order to feed the growing population. There is, and probably always will be, enough water to satisfy municipal and industrial water use.

From the analysis of water resource planning in Egypt, the planning emphasis can be characterised by the following eight points: (1) a shift from water abundance to water deficit; (2) the importance of international co-operation; (3) supply bias; (4) environmental concern; (5) lack of data; (6) established priority to non-agricultural uses of water; (7) delayed implementation; and (8) the establishment of an administrative framework for water resource planning.

Egypt water resource planning is facing a number of problems — such as the lack of funds and a weak administration — which predominate in less-developed economies. In that respect, the impossibility of identifying an operational and fully implemented planning system designed after western standards should not be surprising. Establishing a planning system is expensive, furthermore, and is therefore undertaken only if necessary. Egypt in fact might have had too much water at one time, a surplus which has severely hindered the necessity to implement a planning system. As Wiener forcefully pointed out, the emphasis on water resource planning depends on the scarcity of the resource. The greater the scarcity the more planning is needed to counteract it. According to that argument, it is thus to be expected that Egypt will strengthen its water resource planning capability in the near future, following a greater scarcity of its water supply.