The Master in Optical Communications and Photonic Technologies at Politecnico di Torino

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Summary: The new Italian University Degree System is presented. The Master in Optical Communications and Photonic Technologies of Politecnico di Torino fits into it with a close relationship with the PhD program which can be exploited by those who do not want to immediately look for employment. The Master syllabus is introduced, discussing the rationale behind the chosen course mix. Facilities, including experimental ones, are described. The Master has a powerful and successful internship program, carried out at major multinational companies in the sector, which is commented on in detail. Admission requirements and student performance evaluation are discussed. Future developments as well as European integration are finally explored.

Introduction

Started in the Academic Year 2001/2002, Politecnico di Torino has been offering a Master degree specifically devoted to Optical Communications and Photonic Technologies (MOCPT, http://didattica.polito.it/master/iii/optical.html). This initiative was spurred by the exceptional growth of interest in this field during the previous years. It was mostly aimed at providing graduate students with a higher specialization to allow them to access the job market at the R&D level in high-tech companies.

The burst of the infamous high-tech bubble, however, occurred just when the Master was starting. The following years have been years of deep crisis in the sector, of which only now the end seems to be nearing. Yet, the MOCPT has survived the storm and in fact has been steadily expanding. The first edition counted 7 students, the second 11 and the current edition 14. Projections for the fourth go up to 20 which is close to the structural maximum given the system of teaching which is being used, that relies heavily on the use of computer-aided learning and on hands-on session in a training lab.

This success has been encouraging to those who have worked in the MOCPT organization and teaching staff. The coming into existence of the E-Photon/ONE Network of Excellence (www.e-photon-one.org) will hopefully give us an opportunity to further refine the MOCPT syllabus, and to integrate or merge it with similar initiatives across Europe.
In this paper, several issues regarding the MOCPT will be discussed, ranging from its relationship with the Bologna system of higher education, to course syllabuses, methods of teaching, availability of experimental facilities and the very successful internship program that lets student experience a real work environment within major high-tech multinational companies in the sector.

**The Bologna System and the new Italian University Degree System**

Italy has fully implemented the Bologna System. A scheme of the new Italian University Degree System is shown below.

![Diagram of the new Italian University Degree System](image)

Figure 1: the new Italian University Degree System. The Master MOCPT is a so-called “level II Master”, labeled as “master II” in figure.

To remain in line with tradition, Italy has decided to preserve the old name of university degrees, i.e., “Laurea”. This has been unfortunate, in the opinion of the writer, since it has made it awkward to identify a correspondence between the Italian degrees and all other nations’.

In particular, the “Laurea I” is a three-year degree that effectively corresponds to a “Bachelor”. The “Laurea II” is a two-year degree that effectively corresponds to an Anglo-Saxon System “Master”. Italy has then decided to create two more degrees and call them “Masters”, although their correspondence with the Anglo-Saxon System “Master” is imperfect.

The Italian Master I can be accessed after the Level I Laurea and can still be thought of as a Master degree, albeit a short and lower-level one. The Master II, on the other hand, is not really a Master in the Anglo-Saxon sense. Rather, it is a higher specialization degree of the post-graduate type. The MOCPT to which this paper is devoted, is a Master II.

Even though the MOCPT was conceived as a professionalizing degree, albeit at R&D level, the School of Information Engineering of Politecnico di Torino has decided that
those who earn a Master II degree like MOCPT and do not want to immediately look for employment, can enroll in a PhD program and carry it out in a minimum time span of two years rather than three. This further confirms the post-graduate nature of the Master II’s and of MOCPT in particular.

Note that according to the Italian scheme, a student willing to get enrolled in the MOCPT must already have a 5-year degree. In other words, to be in an Italian Master II program, you need to already have an Anglo-Saxon System Master degree. This does induce some confusion but due to the current laws there are no plans for now to change this situation.

The MOCPT Schedule and Syllabus

The MOCPT is a one-year degree. It is divided into the four usual quarters, from Fall to Summer. The schedule is shown below in Fig. 2.

Since most students come from outside Italy, a “warm-up” period is appended before lessons start, in which foreign students get acquainted with Politecnico, take Italian classes and get used to the environment. The Italian that students take is meant only to help them with their everyday life in Torino, since all classes are taught and examined in English.

The final “exam recovery” session is in fact embedded in the last part of the Summer quarter and more will be said about it later.

The MOCPT syllabus is organized along three main cultural lines:

1. optical components and technologies
2. optical transmission systems
3. optical networks
From Fig. 2 it is easily seen that each of these cultural lines is devoted three classes, so each one of them is equally represented in the Master. The only course outside of this subdivision is a preparatory one, which deals with Fourier transforms, stochastic processes and the basics of digital transmission. Students are assumed to be already proficient in these areas, but it has been found that a refresh of such notions greatly helped students confront with the more complex topics of the other classes. A detailed syllabus of each course can be found at:
http://didattica.polito.it/master/III/optical.html

This perfect balance among cultural areas was specifically designed to enable students to look for, find and possibly change jobs across the whole optical networking sector. In addition, it is believed by the MOCPT staff that a more complete understanding of all aspects of optical networking contributes to making all-round experts capable of better performing in whatever task they are assigned.

Teaching takes place in a specifically devoted classroom, equipped with computers. Each student has one, that becomes his or her own PC throughout the duration of the Master. Outside of class hours, students use the classroom as a studying lounge and can carry out homework using their computers.

Teaching itself takes advantage of computer-aided training sessions, based on various simulation and CAD tools. For instance, for the Optical Transmission I and II classes, the commercial system simulation tool OptSim (by RSoft inc.) is used. Homework may also involve writing programs in either C, Fortran, or using Matlab and similar sophisticated software tools.

To form a culturally complete expert, theory alone is not sufficient, even when complemented by simulations or CAD. Hands-on training is indispensable. To the purpose of making students familiar with optical components and systems, as well as their characterization and handling, a specifically devoted teaching lab was set up, called LADIOT. Students carry out such tasks as characterizing fibers using an OTDR, splicing fibers using state-of-the-art splicers, measure the P/I curve of laser diodes, build simple 1 Gbit/s optical transmission systems and measure their BER performance, build an EDFA by assembling its subcomponents and then characterize it, etc.

At least one lab experience is carried out within the new optical networks research laboratory of Politecnico di Torino, called PhotonLab (www.photonlab.org). This large
and well-equipped research facility (see Fig. 3) is typically accessible only to staff and PhD students. This year, 10 Gbit/s system tests were performed there by MOCPT students.

**The Internships**

Since the MOCPT primary goal was that of giving people an edge in the high-tech job market, it is believed that experiencing a company environment would be of fundamental value to the MOCPT students.

As result, all MOCPT students carry out an internship from the beginning of June to the end of September. Internships thus total approximately 4 months, effectively taking the whole of the Summer quarter and bits of the neighboring quarters.

Several top companies have agreed to host such internships. Among them, Agilent Technologies (Turin), Telecom Italia Labs (Turin), Pirelli Labs (Milan), Avanex (Milan) and from next year Alcatel (Milan).

The above lists shows that the Turin/Milan area is especially privileged as to the number and quality of high-tech companies in the sector. In addition, internships positions have also be granted by Fastweb, of the E.Biscom group. Fastweb is world-renowned high-tech operator bringing actual fiber-to-the-home to several hundreds of thousand of residential customers in Italy. Its business model and successes are currently widely studied throughout the world. Fastweb too is based in both Turin and Milan.

As a measure of the success of the MOCPT and its internship program, a large percentage (about 50%) of the MOCPT students have been offered jobs at the end of their internships by the same companies that hosted them.

**Admission Requirements and Geographical Distribution of Applicants**

As pointed out earlier, the MOCPT is a Level II Master in the new Italian System. Therefore all students willing to enroll, either Italian or foreign, must already have a 5-year university degree (that is, they must already have an Anglo-Saxon system Master). The subject of such degree must be Electrical Engineering or Computer Engineering or Physics.

Apart from formally certifiable degrees, in the MOCPT enrollment form it is clearly spelled out that all applicants are supposed to have a sound cultural background encompassing the following subjects:

- Fourier Transforms
- Stochastic Variables and Processes
- Elements of Digital Transmission
- Elements of Communication Networks Protocols
- Basics of Semiconductor Devices and Materials
- Transmission Line Theory
- Basics of Analog and Digital Electronic Circuits
- Basics of Electromagnetic Wave Propagation

As a self-evaluation procedure, the applicant is requested to tick boxes indicating in which one of these subjects he/she has a sound background. The form then says that a lack of sufficient knowledge in more than two of such subjects is not acceptable.

Those who designed the form do not fool themselves into believing that students will always tell the truth. However, at this higher education level, it is believed that individuals are already self-responsible enough so that most of those who read the above list and find out their background is not well-matched to what is required, will refrain from applying.

So far, the MOCPT students have mostly come from South America (Brazil, Argentina, Ecuador, Mexico, Chile, Venezuela, etc.). In addition a minority of Italian students have enrolled as well. The reason for the prevalence and success of South America is due to an aggressive grant program funded by Italian Local Government authorities and Bank Foundations, aimed specifically at South American countries.

Starting from this coming academic year (2004/2005), grants will be available (in different forms and amounts) to South America (http://www2.polito.it/didattica/alpip/), Mediterranean countries (http://www2.polito.it/didattica/topmed/) and EEC students, the latter directly from Politecnico.

**Student Performance Evaluation**

From the start, it was decided that a rather strict student proficiency evaluation system should be put in place.

All ten courses taught in the MOCPT have an examination at the end, either written, oral or sometimes both. In addition, most of them require that homework and reports on lab sessions be turned in. These are graded and typically make up part of the final course grade.

Students are allowed to take a course exam only twice. The first time is right after the course ends. The second time is in the “recovery session” after the Summer quarter, as shown in Fig. 2. If a student fails an exam both times, then the fail is confirmed and cannot be recovered.

In order to receive the official Master degree from Politecnico di Torino, one confirmed fail is tolerated, only. If a student ends the Master with more than one confirmed fail, he/she will only receive a Certificate of Passed Exams for those classes whose exams were successfully passed.

A barrier is also in place after the Spring quarter to prevent students that are not sufficiently proficient from going on to the Summer internship without the necessary level of acquired cultural background. To be able to attend the internship, students must have passed at least six out of the ten course examinations. Those who have not,
cannot go on to the internship. If they wish to, they may spend the Summer quarter studying to recover for the failed examinations. Eventually they will not be given the Master degree, even if they recover all exams, because they lack the internship. They may later attend the internship beyond the one-year Master term, if the choose to do so, to eventually get the degree.

All in all, the above system should ensure that all individuals who receive a MOCPT degree have well earned their degree and that they have acquired a good cultural level in the MOCPT topics.

**Future Developments and European Integration**

A new feature which has been implemented in the current Academic Year (2003/2004), is an easier path towards a continuation into the PhD program.

Originally, The Master was meant to be a professionalizing one, although at a very high specialization level. However, many students, after attending the MOCPT, have expressed their wish to go on to a PhD program. To allow students to make this commitment earlier and more profitably, the Summer quarter internship at a company can be replaced, by those willing to go on to a PhD, with a research project internship at the optical networks laboratory of Politecnico di Torino ([www.photonlab.org](http://www.photonlab.org)).

These students will have to pass the qualification exams after the Master ends but, as previously pointed out, if admitted to the PhD program, they will be able to complete it in one year less than the regular PhD program.

Due to the coming into existence of the FP6 Network of Excellence E-Photon/ONE ([www.e-photon-one.org](http://www.e-photon-one.org)), the MOCPT staff have declared their willingness to coordinate syllabuses and exchange teachers with other similar initiatives across Europe.

One possible way to do so would be to pick certain key classes and establish a common syllabus for them. In addition, the teaching material (slides or other) could be jointly developed and then used at different locations. Teachers contributing to the development might then freely circulate and teach at collaborating universities within an exchange program sponsored by E-Photon/ONE, aimed at integrating such universities and teaching programs in a stricter and more effective way.

As further step along this avenue, different universities might grant the same degree based on the same syllabuses and the same teaching material and procedures, and students might be able to take some classes at one site and some others at another site.

One possible target of this integration project could be that of establishing an official E-Photon/ONE Master in Optical Communications and Networks, taught at different locations and allowing for a certain degree of student exchange and circulation.
Conclusion

The Master in Optical Communications and Photonic Technologies of Politecnico di Torino has been so far a positive and successful enterprise. Thanks to the European cooperation being set up through the Network of Excellence E-Photon/ONE it is hoped that this and similar initiatives in Europe may join and produce a modern, effective and culturally sound common degree whereby both students and teacher might circulate among sites and take advantage of different personal experiences and multicultural diversity.

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