



ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
HELLENIC REPUBLIC



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**Accreditation Report
for the Undergraduate Study Programme
(Integrated Master) of:**

**Chemical Engineering
Institution: National Technical University of Athens
Date: 22 May 2021**



Επιχειρησιακό Πρόγραμμα
Ανάπτυξη Ανθρώπινου Δυναμικού,
Εκπαίδευση και Διά Βίου Μάθηση
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης



Report of the Panel appointed by the HAHE to undertake the review of the Undergraduate Study Programme (Integrated Master) of **Chemical Engineering** of the **National Technical University of Athens** for the purposes of granting accreditation

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PART A: BACKGROUND AND CONTEXT OF THE REVIEW

I. The External Evaluation & Accreditation Panel

The Panel responsible for the Accreditation Review of the Undergraduate Study Programme (Integrated Master) of **Chemical Engineering** of the **National Technical University of Athens** consisted of the following five (5) members, selected from the HAHE Register, in accordance with Laws 4009/2011 & 4653/2020:

- 1. Professor Ioannis P. Androulakis (Chair)**
Rutgers, The State University of New Jersey, USA
- 2. Professor Georgios M. Kontogeorgis**
Technical University of Denmark (DTU), Denmark
- 3. Mr. Pantelis Pantelaras**
Manager, Ravago Chemicals, Hellas SA –
Member of the Technical Chamber of Greece, Greece
- 4. Professor Vladimiro Papangelakis**
University of Toronto, Canada
- 5. Professor and Dean of Engineering Yannis Yortsos**
University of Southern California, USA

II. Review Procedure and Documentation

Because of COVID-19 restrictions the review was conducted via teleconference (Zoom). It was organized and coordinated by HAHE with the help of the School of Chemical Engineering, NTUA (National Technical University of Athens). The schedule and agenda of the meetings were as follows:

Monday, May 17, 2021: Preliminary private meeting of the Panel.

Tuesday, May 18, 2021: Consecutive meetings with the following agenda

- a) Welcome and short overview of the undergraduate programme (UP) with the vice-Rector/President of MODIP and the School Head.
- b) Discussion of degree compliance of the UP to the quality standards for accreditation with OMEA members and staff and MODIP representatives.
- c) Private debriefing (Panel members only).

Wednesday, May 19, 2021: Consecutive meetings with the following agenda

- a) Discussion with faculty, teaching, and staff members.
- b) Discussion with current undergraduate students.
- c) Discussion with Assistant Professors.
- d) Private debriefing (Panel members only)

Thursday, May 20, 2021: Consecutive meetings with the following agenda

- a) Discussion with programme graduates.
- b) Discussion with employers and social partners.
- c) Private debriefing (Panel members only).
- d) Discussion with OMEA and MODIP representatives on points needing clarification.
- e) Informal presentation of the EEAP key finding to the vice-Rector, Head of the School, OMEA and MODIP.

Friday, May 21, 2021: Private meeting of the Panel for report writing.

Saturday, May 22, 2021: Private meeting of the Panel for report writing.

Sunday, May 23, 2021: Electronic (e-mail) communication between Panel members to finalize report.

In preparation for the visit, the Panel received a multitude of material that included background information on accreditation, detailed data related to the programme under evaluation, and operational and educational data. The Panel was in close communication with IEG (OMEA) and QAU (MODIP) representatives who were very accommodating in providing additional information. The Panel also found that IEG (OMEA) and QAU (MODIP) representatives as well as the faculty, students and staff interviewed were eager and helpful in providing all information requested by the Panel.

III. Study Programme Profile

The School of Chemical Engineering of the National Technical University of Athens (NTUA) was established in 1917. The stated mission of the current programme is to “educate engineers able to apply basic mathematical, physical, chemical, and biological principles to the design, development and optimization of processes, systems and products in a wide range of domains, including materials, energy and environment”. The programme aims at providing its students with a broad, yet solid foundation of basic chemical engineering principles, enabling its graduates to address a diverse array of global challenges. We have considered these statements as also standing for the programme *educational objectives*. The task of the Panel was to evaluate the undergraduate educational programme, therefore this report will heavily focus on the undergraduate programme, although some comments related to graduate education and research will also be included below, as appropriate.

The School is housed in facilities encompassing 9500 m² of laboratory space, 1785 m² of teaching space (2 auditoria and 15 general purpose classrooms), 1971 m² of office space, 1450 m² of administrative space and 17000 m² of common space. The current faculty is comprised of 37 full professors, 12 associate professors and 3 assistant professors. All educational activities are further supported by 62 members who provide technical and educational support and 14 administrative staff members who provide administrative support. Currently, more than 1800 undergraduate students are registered in the School. Even though the duration of the undergraduate studies is 5 years (10 semesters), a substantial fraction of the undergraduate student body (reported to us to be close to 40%) has been enrolled for more than 7 years. Students are expected to successfully complete a total of 40 core, 3 elective and 5 specialization courses, as well as a Diploma Thesis and a one-month industrial internship. This totals to 300 ECTS, thus leading to a Level 7 Qualification (Integrated Master) as defined by the National & European Qualifications Network. The School faculty maintain an active research portfolio. The School’s international rankings, as reported by QS World University Rankings, which reflect a blend of graduate and undergraduate strengths, are respectable. It was not clear to the Panel the importance of such rankings to the School’s real stature and/or the allocation of resources from NTUA or the Greek State.

PART B: COMPLIANCE WITH THE PRINCIPLES

Principle 1: Academic Unit Policy for Quality Assurance

INSTITUTIONS SHOULD APPLY A QUALITY ASSURANCE POLICY AS PART OF THEIR STRATEGIC MANAGEMENT. THIS POLICY SHOULD EXPAND AND BE AIMED (WITH THE COLLABORATION OF EXTERNAL STAKEHOLDERS) AT ALL INSTITUTION'S AREAS OF ACTIVITY, AND PARTICULARLY AT THE FULFILMENT OF QUALITY REQUIREMENTS OF UNDERGRADUATE PROGRAMMES. THIS POLICY SHOULD BE PUBLISHED AND IMPLEMENTED BY ALL STAKEHOLDERS.

The quality assurance policy of the academic unit is in line with the Institutional policy on quality, and is included in a published statement that is implemented by all stakeholders. It focuses on the achievement of special objectives related to the quality assurance of study programmes offered by the academic unit.

The quality policy statement of the academic unit includes its commitment to implement a quality policy that will promote the academic profile and orientation of the programme, its purpose and field of study; it will realise the programme's strategic goals and it will determine the means and ways for attaining them; it will implement the appropriate quality procedures, aiming at the programme's continuous improvement.

In particular, in order to carry out this policy, the academic unit commits itself to put into practice quality procedures that will demonstrate:

- a) the suitability of the structure and organization of the curriculum;*
- b) the pursuit of learning outcomes and qualifications in accordance with the European and the National Qualifications Framework for Higher Education;*
- c) the promotion of the quality and effectiveness of teaching;*
- d) the appropriateness of the qualifications of the teaching staff;*
- e) the enhancement of the quality and quantity of the research output among faculty members of the academic unit;*
- f) ways for linking teaching and research;*
- g) the level of demand for qualifications acquired by graduates, in the labour market;*
- h) the quality of support services such as the administrative services, the Library, and the student welfare office;*
- i) the conduct of an annual review and an internal audit of the quality assurance system of the undergraduate programme(s) offered, as well as the collaboration of the Internal Evaluation Group (IEG) with the Institution's Quality Assurance Unit (QAU).*

Study Programme Compliance

The School's mission, as articulated in the previous section, is reflected well in the structure and the expected outcomes of the undergraduate programme and the means to achieve them. Teaching effectiveness is assessed by regularly monitoring student progress and student satisfaction. The faculty are motivated and clearly care deeply about the students' progress. They are involved in a wide range of research activities, with a reasonable variability among the different faculty. Such involvement is critical to enabling student exposure in the latest developments in Chemical Engineering, which occurs primarily through the Diploma Thesis, which is supervised by the faculty, thereby linking teaching and research. Opportunities also exist for students to be involved in industry-initiated Diploma Theses, thus further enhancing

student exposure to industry needs. The School's teaching and administrative staff provides appropriate teaching, support and administrative services to the programme and the School. The Internal Evaluation Group and the Institution Quality Assurance Unit review the programme's performance annually and communicate their findings to the faculty and the School Dean.

The Panel finds that overall, the programme fully complies with Principle 1.

Panel Judgement

Principle 1: Academic Unit Policy for Quality Assurance	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- In typical educational assessments, outcomes and the corresponding curricular and programmatic structure are assessed by their relation to the programme's educational objectives, which as a result set the overarching goals of the programme. The Panel believes that such objectives, for example in the mission statement, can not only be better articulated but also allow for the continuous evolution and adaptation of the programme to meet them, given the dynamic, constantly changing nature of the marketplace in today's rapidly evolving local and global environments. The pace of change in science, engineering and innovation has been accelerating, and it is paramount for educational institutions to be able to follow it, if not to lead it. Enabling the programme to respond in an agile manner with curricular and extra-curricular changes that meet the current requirements and future trends of the workplace, will help prepare graduates who will be able to address the many grand challenges that continuously emerge today, from sustainability to health to security and to well-being.
- In addition, and as a consequence, we recommend that the programme develops formal and quantifiable measures for developing criteria that will guide curriculum updates and course updates. Quantitative reasoning in terms of measurable outcomes, in lieu of *ad hoc* decisions, should guide programme updates. Further, such decisions need to be openly discussed, assessed, and approved by the School and should be aligned with clearly defined long-terms goals and educational objectives.

Principle 2: Design and Approval of Programmes

INSTITUTIONS SHOULD DEVELOP THEIR UNDERGRADUATE PROGRAMMES FOLLOWING A DEFINED WRITTEN PROCESS WHICH WILL INVOLVE THE PARTICIPANTS, INFORMATION SOURCES AND THE APPROVAL COMMITTEES FOR THE PROGRAMME. THE OBJECTIVES, THE EXPECTED LEARNING OUTCOMES, THE INTENDED PROFESSIONAL QUALIFICATIONS AND THE WAYS TO ACHIEVE THEM ARE SET OUT IN THE PROGRAMME DESIGN. THE ABOVE DETAILS AS WELL AS INFORMATION ON THE PROGRAMME'S STRUCTURE ARE PUBLISHED IN THE STUDENT GUIDE.

Academic units develop their programmes following a well-defined procedure. The academic profile and orientation of the programme, the objectives, the subject areas, the structure and organisation, the expected learning outcomes and the intended professional qualifications according to the National Qualifications Framework for Higher Education are described at this stage. The approval or revision process for programmes includes a check of compliance with the basic requirements described in the Standards, on behalf of the Institution's Quality Assurance Unit (QAU).

Furthermore, the programme design should take into consideration the following:

- the Institutional strategy*
- the active participation of students*
- the experience of external stakeholders from the labour market*
- the smooth progression of students throughout the stages of the programme*
- the anticipated student workload according to the European Credit Transfer and Accumulation System*
- the option to provide work experience to the students*
- the linking of teaching and research*
- the relevant regulatory framework and the official procedure for the approval of the programme by the Institution*

Study Programme Compliance

The programme has developed internal procedures for continuously assessing the effectiveness of the curriculum and teaching. The curriculum compares well with internationally accepted standards. Overall, the School prepares well its graduates, and it provides them with good opportunities for gaining work and research experience.

At the same time, the Panel noted that input from critical constituencies and stakeholders, who will influence how the graduates meet the stated mission and/or educational objectives, is not solicited routinely and systematically. For the same reasons as mentioned in the previous section, this lack of critical assessment and feedback limits the ability of the curriculum to keep up with the latest developments and needs in the field. In fact, it was not clear to the Panel what is the institutional strategy for ascertaining alignment.

The Panel finds that the programme is substantially compliant with Principle 2.

Panel Judgement

Principle 2: Design and Approval of Programmes	
Fully compliant	
Substantially compliant	X
Partially compliant	
Non-compliant	

Panel Recommendations

To further improve adherence to this Principle, the Panel recommends the following action:

- Critical stakeholders (alumni, companies, graduate schools, and other organizations employing or further training graduates) must actively participate in the continuous assessment, and possible improvement, of the curriculum. This participation should be done in a formal, systematic, and transparent way with clearly defined objectives, and with feedback solicited in a rigorous way. Importantly, all stakeholder representatives with whom the Panel met, expressed strong support and enthusiasm for furthering their interactions with the School.
- An external advisory board (EAB) must be formed, consisting of various stakeholder representatives, and with key objectives to provide useful guidance on teaching, research and other impact activities, while also serving as champions and external advocates of the School. The EAB should meet at least annually. The Panel met with several such stakeholders who expressed enthusiastic support for this recommendation.
- The Panel recognizes the positive impact of the substantial changes recently implemented on the reduction of coursework, and the focus of electives, and applauds the School for being pro-active.
- Pre-requisites must be applied, where necessary, throughout the curriculum. The Panel also debated the need for foreign language instruction, specifically for English, which could be considered as a requirement for admission, and which will have the side benefit of also allowing for some instruction in English. The later will not only improve the student experience; it will also enhance the School's participation in student exchange initiatives, and further open the possibility of offering online degrees to a wider international audience if such decision is eventually made.
- It is not clear to the Panel why the Diploma Thesis, is graded in the usual way, instead of being assessed via a pass/fail grading system. The current grading system for the Diploma Thesis, in conjunction with the facts that it is generally graded with high grades and that it counts for 20% of the final grade, inevitably leads to grade inflation and misrepresents the student's overall performance. The Panel recommends that this observation is given serious consideration.

- While the practical training experience is mandatory, its normal duration of 1 month appears to limit its impact. The Panel strongly recommends that the programme identifies new ways for increasing the length of this experience to increase its value and impact.
- More generally, the programme should seek a higher industry participation in the educational enterprise, for example by participating in capstone design projects, providing visitors for lectures, and perhaps also participating in helping select Diploma Thesis topics and offering corresponding mentorship to the students.
- Finally, the Panel observed that while interdisciplinary programmes are offered at the graduate level, they are not available to the undergraduate programme. Perhaps, this weakness reflects institutional constraints that transcend the School of Chemical Engineering and apply across the entire NTUA. Regardless, the Panel found that the absence of undergraduate specializations in majors, such Biomedical or Biochemical Engineering, or Environmental Engineering, is a significant institutional weakness that must be rectified, perhaps by offering options within the integrated degree granted.

Principle 3: Student- centered Learning, Teaching and Assessment

INSTITUTIONS SHOULD ENSURE THAT THE UNDERGRADUATE PROGRAMMES ARE DELIVERED IN A WAY THAT ENCOURAGES STUDENTS TO TAKE AN ACTIVE ROLE IN CREATING THE LEARNING PROCESS. THE ASSESSMENT METHODS SHOULD REFLECT THIS APPROACH.

Student-centered learning and teaching plays an important role in stimulating students' motivation, self-reflection and engagement in the learning process. The above entail continuous consideration of the programme's delivery and the assessment of the related outcomes.

The student-centered learning and teaching process

- *respects and attends to the diversity of students and their needs, enabling flexible learning paths;*
- *considers and uses different modes of delivery, where appropriate;*
- *flexibly uses a variety of pedagogical methods;*
- *regularly evaluates and adjusts the modes of delivery and pedagogical methods aiming at improvement;*
- *regularly evaluates the quality and effectiveness of teaching, as documented especially through student surveys;*
- *reinforces the student's sense of autonomy, while ensuring adequate guidance and support from the teaching staff;*
- *promotes mutual respect in the student - teacher relationship;*
- *applies appropriate procedures for dealing with students' complaints.*

In addition :

- *the academic staff are familiar with the existing examination system and methods and are supported in developing their own skills in this field;*
- *the assessment criteria and methods are published in advance;*
- *the assessment allows students to demonstrate the extent to which the intended learning outcomes have been achieved. Students are given feedback, which, if necessary is linked to advice on the learning process;*
- *student assessment is conducted by more than one examiner, where possible;*
- *the regulations for assessment take into account mitigating circumstances;*
- *assessment is consistent, fairly applied to all students and carried out in accordance with the stated procedures;*
- *a formal procedure for student appeals is in place.*

Study Programme Compliance

The study programme is delivered in a student-centred manner that promotes mutual respect. It makes use of all the basic monitoring, assessing and survey tools, e.g., student satisfaction surveys, the recently established formal student appeal process and other forms of interaction. We expect that these recent innovations are being broadly communicated to the students. The faculty demonstrate strong interest and enthusiasm in the educational process. Contact with the students is very close at all levels. The "open door" policy is noteworthy and should be applauded. Overall, the students interviewed by the Panel are very satisfied with their studies.

On the other hand, the Panel finds that the study programme is dense, with few opportunities for the students to follow flexible learning paths, including taking courses for credit outside their

own major, which hinders the possible adaptation to changing societal needs, science and technology trends and student interests. With the structure of the curriculum restrictive within the confines of the School, such critical opportunities for student learning are missed. The Panel also finds that there is no programme in place for the teaching faculty to be exposed to modern pedagogical methods, more suitable for current and future generations of students.

The Panel finds that the programme is substantially compliant with Principle 3.

Panel Judgement

Principle 3: Student- centred Learning, Teaching and Assessment	
Fully compliant	
Substantially compliant	X
Partially compliant	
Non-compliant	

Panel Recommendations

To further improve adherence to this Principle, the Panel recommends the following action:

- While appreciating the fact that students can now take courses also from other “Directions”, the Panel does not find it sufficient to cover the rapidly changing pace in science, technology and engineering that is certain to impact the students’ careers. These diverse needs must be addressed with more flexible learning paths, including the following:
 - i. Students should be able to take courses from other programmes outside the confines of the School, which will formally count towards the ECTS needed to fulfil the programme (restrictions on courses to be decided by the curriculum committee).
 - ii. Create an “Independent Research” elective course, for purposes of preparing students for their diploma thesis projects, enriching their research experience and/or enabling students to develop a deeper understanding of topics of interest. Such course should also earn students ECTS towards their degree.
- Incentives and support must be given to faculty members to deploy new pedagogical approaches and methodologies aiming at improving the learning experience. Such courses could be made mandatory for all junior faculty. In parallel, it should also be investigated whether such pedagogy courses can be taken by other NTUA schools as well.

- For the majority of the course, the grade depends disproportionately on the final examination. The faculty should implement a variety of other assessment tools, including open-book exams, projects, oral presentations, etc. An additional benefit of such a change would be incentivizing more active student's participation in the class.
- Formal grievance and Grade Appeal procedures must be implemented to allow students to address academic issues in a formal way. Currently, these are handled in an *ad hoc* way.

Principle 4: Student Admission, Progression, Recognition and Certification

INSTITUTIONS SHOULD DEVELOP AND APPLY PUBLISHED REGULATIONS COVERING ALL ASPECTS AND PHASES OF STUDIES (ADMISSION, PROGRESSION, RECOGNITION AND CERTIFICATION).

Institutions and academic units need to put in place both processes and tools to collect, manage and act on information regarding student progression.

Procedures concerning the award and recognition of higher education degrees, the duration of studies, rules ensuring students progression, terms and conditions for student mobility should be based on the institutional study regulations. Appropriate recognition procedures rely on institutional practice for recognition of credits among various European academic departments and Institutions, in line with the principles of the Lisbon Recognition Convention.

Graduation represents the culmination of the students' study period. Students need to receive documentation explaining the qualification gained, including achieved learning outcomes and the context, level, content and status of the studies that were pursued and successfully completed (Diploma Supplement).

Study Programme Compliance

The quality of students and the fraction that select the School as first choice has steadily increased during the last 5 years. Incoming students are introduced through their first year to the nature of the academic programme. The recently instituted concept of the “counselling professor” is welcome in helping guide students through the programme. Student progression is monitored by means of a centralized tracking system that includes the Internal Quality Assurance System (OMEA). The ECTS system is applied throughout the curriculum. The Diploma Thesis is well-structured, and a Thesis Handbook is available to students. Practical training to an industrial setting is compulsory for all students. Student mobility by means of the Erasmus+ programme is heavily promoted, and the School has developed a well-thought system to rank and select eligible students, although the number of students taking advantage of the programme can be higher. The School has developed a network of industry and research institutes to identify placements. Of note is the fact that the Diploma supplement is issued by request and not by default. Of notable concern is that about 40% fraction of students in residence in the programme exceed two years beyond the nominal five. At the same time, the Panel notes the encouraging trend that over recent years the fraction of students completing their studies on time (or almost on time) has increased substantially.

The Panel finds that overall, the programme fully complies with Principle 4.

Panel Judgement

Principle 4: Student Admission, Progression, Recognition and Certification	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- A Diploma Supplement should be issued to all graduating students without the need for the student to request it.
- As noted in a prior section, practical training should be extended to more than one month to help a more meaningful experience and strengthen industry and other stakeholder relations. To accomplish this goal, the curriculum could be restructured in the timing of courses offered, for the duration of practical training to be extended from a minimum of one semester (4 months) to a maximum of a full year (for willing students) with student financial support from the industry, before the students return to complete the degree.
- The School should consider ending classes one week before the start of the final exam period in each semester to help students manage stress levels and minimize mental health issues.
- The number of years a student can remain enrolled with no apparent progress should be limited. Continuation of this undesirable trend will ultimately have detrimental consequences to the quality and reputation of the programme and the value of the degree awarded.
- For the above reason, more focus should be directed towards students struggling to complete their studies on time, given that a significant fraction of the enrolled students falls in that category. Proposed solutions should be sought within the current governance framework, e.g., by suitable questionnaires and surveys aimed at enrolled students who are beyond their 7th year of studies. While perhaps time-consuming, this is a worthwhile process. This should be considered a point of priority, although the Panel understands the various associated institutional and political constraints.
- Care should be taken so that the concept of “counselling professor” does not operate on an ad-hoc basis due to the open-door policy of the School. In addition, formal procedures for student support and conflict resolution should be established. Although the open-door policy helps in this direction, it does not guarantee that all students take advantage of it. While personal support and conflict resolution does not necessarily guarantee that issues arising are resolved equitably.

Principle 5: Teaching Staff

INSTITUTIONS SHOULD ASSURE THEMSELVES OF THE QUALIFICATIONS AND COMPETENCE OF THE TEACHING STAFF. THEY SHOULD APPLY FAIR AND TRANSPARENT PROCESSES FOR THE RECRUITMENT AND DEVELOPMENT OF THE TEACHING STAFF.

The Institutions and their academic units have a major responsibility as to the standard of their teaching staff providing them with a supportive environment that promotes the advancement of their scientific work. In particular, the academic unit should:

- *set up and follow clear, transparent and fair processes for the recruitment of properly qualified staff and offer them conditions of employment that recognize the importance of teaching and research;*
- *offer opportunities and promote the professional development of the teaching staff;*
- *encourage scholarly activity to strengthen the link between education and research;*
- *encourage innovation in teaching methods and the use of new technologies;*
- *promote the increase of the volume and quality of the research output within the academic unit;*
- *follow quality assurance processes for all staff members (with respect to attendance requirements, performance, self-assessment, training etc.);*
- *develop policies to attract highly qualified academic staff.*

Study Programme Compliance

The teaching staff is of high quality and demonstrates a great degree of collegiality. The School follows the legal process for the recruitment of new faculty, arguably all of high quality. Research activities are monitored with Scopus; the teaching excellence with student evaluations. Research productivity and teaching quality are on a steady rise during the last 5 years. The School is actively promoting the increase in research productivity in terms of publication outputs and research funding. Teaching loads appear to exceed the expected minimum by almost 80%, with a substantial standard deviation of 30%. Eight percent of the teaching staff is mobile every year by means of the Erasmus+ programme.

There is strong evidence of the linking of teaching with research given the School's research output. The undergraduate programme offers four specialization areas ("Directions") although these are not specified in the Diploma and transcripts.

The teaching staff is evaluated by student surveys, although the student participation is low, and as a result, not very meaningful. The evaluation results are communicated to the teaching staff sporadically and lack comparison with NTUA or School benchmarks. No specific training in teaching innovation of the academic staff is offered.

The Panel finds that the programme is substantially compliant with Principle 5.

Panel Judgement

Principle 5: Teaching Staff	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further improve adherence to this Principle, the Panel recommends the following action:

- Teaching evaluations should be systematically communicated to individual instructors in an organized and systematic way. Metrics to compare individual instructor performance to the average evaluations of the School and NTUA for all key performance questions should be developed. The School should inform widely the students that teaching evaluations are used to improve course delivery, instructor methods, and the curriculum, and that they are taken seriously, in order to help increase student participation.
- Annual faculty loads (namely percentage of effort in teaching, research and service) for faculty, both ΔΕΠ and ΕΔΙΠ, need to be articulated. Annual faculty performance should be collected via faculty input and be evaluated by faculty peer committees. In this way, a feedback loop between faculty load and assignments and faculty performance can be created to help increase excellence.

Principle 6: Learning Resources and Student Support

INSTITUTIONS SHOULD HAVE ADEQUATE FUNDING TO COVER TEACHING AND LEARNING NEEDS. THEY SHOULD –ON THE ONE HAND- PROVIDE SATISFACTORY INFRASTRUCTURE AND SERVICES FOR LEARNING AND STUDENT SUPPORT AND–ON THE OTHER HAND- FACILITATE DIRECT ACCESS TO THEM BY ESTABLISHING INTERNAL RULES TO THIS END (E.G. LECTURE ROOMS, LABORATORIES, LIBRARIES, NETWORKS, BOARDING, CAREER AND SOCIAL POLICY SERVICES ETC.).

Institutions and their academic units must have sufficient funding and means to support learning and academic activity in general, so that they can offer to students the best possible level of studies. The above means could include facilities such as libraries, study rooms, educational and scientific equipment, information and communications services, support or counselling services.

When allocating the available resources, the needs of all students must be taken into consideration (e.g. whether they are full-time or part-time students, employed or international students, students with disabilities) and the shift towards student-centred learning and the adoption of flexible modes of learning and teaching. Support activities and facilities may be organised in various ways, depending on the institutional context. However, the internal quality assurance ensures that all resources are appropriate, adequate, and accessible, and that students are informed about the services available to them.

In delivering support services the role of support and administrative staff is crucial and therefore they need to be qualified and have opportunities to develop their competences.

Study Programme Compliance

The School of Chemical Engineering has adequate funding to support learning and teaching activities to cover the academic needs of its students. It has appropriately qualified and trained faculty to deliver all aspects of the curriculum. Sufficient members of Faculty (ΔΕΠ, ΕΔΙΠ) are available for teaching and for the supporting laboratories. Classroom and laboratory space and adequate computing resources are in place. A range of support services, like dormitories, career counselling, student welfare office, sport and cultural facilities etc. are provided centrally by NTUA.

The Panel also recognizes that substantial funding pressures exist, limiting the School's ability to properly maintain its laboratories, buildings, and equipment.

The Panel finds that overall, the programme fully complies with Principle 6.

Panel Judgement

Principle 6: Learning Resources and Student Support	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- Even though many budgeting issues are above and beyond its control, the School should nonetheless actively pursue and advocate for funds to maintain and upgrade its facilities. Furthermore, the overall security of the premises needs to be improved to minimize random acts of vandalism.
- To address potential office space scarcity, so that newly recruited faculty can be accommodated, retired faculty should be asked to vacate their offices, perhaps sharing only one common lounge space.
- The School, perhaps through NTUA, should pursue the creation of a “Maker Space” (<http://www.makerspaceforeducation.com/makerspace.html>) providing students with a significant hands-on venue for exploring their creativity.

Principle 7: Information Management

INSTITUTIONS BEAR FULL RESPONSIBILITY FOR COLLECTING, ANALYSING AND USING INFORMATION, AIMED AT THE EFFICIENT MANAGEMENT OF UNDERGRADUATE PROGRAMMES OF STUDY AND RELATED ACTIVITIES, IN AN INTEGRATED, EFFECTIVE AND EASILY ACCESSIBLE WAY.

Institutions are expected to establish and operate an information system for the management and monitoring of data concerning students, teaching staff, course structure and organisation, teaching and provision of services to students as well as to the academic community.

Reliable data is essential for accurate information and for decision making, as well as for identifying areas of smooth operation and areas for improvement. Effective procedures for collecting and analysing information on study programmes and other activities feed data into the internal system of quality assurance.

The information gathered depends, to some extent, on the type and mission of the Institution. The following are of interest:

- *key performance indicators*
- *student population profile*
- *student progression, success and drop-out rates*
- *student satisfaction with their programme(s)*
- *availability of learning resources and student support*
- *career paths of graduates*

A number of methods may be used for collecting information. It is important that students and staff are involved in providing and analyzing information and planning follow-up activities.

Study Programme Compliance

The programme has developed a satisfactory information management system for its current students. Suitable KPIs have been established, and there is clear availability of learning resources, as well as student support both formally and informally. Student progression, success, and drop-out rates are carefully monitored.

The programme has several excellent collaborations with its graduates, including both joint research and educational activities. This is particularly praiseworthy. The career paths of graduates are not monitored systematically, although the Panel does understand the complicated nature of such a task. Nonetheless, initiatives towards improvement should be considered.

The Panel finds that overall, the programme fully complies with Principle 7.

Panel Judgement

Principle 7: Information Management	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- The programme must establish a transparent way by which the student evaluations are included in the annual faculty assessment, e.g., via the existing Education/Study Programme Committee or by some other way. These should be shared with faculty peer committees, not just the School Dean. Assistance from the NTUA central administration may be needed so that student surveys are completed immediately upon the completion of the course.
- Moreover, students must become aware of the importance of the evaluation process so that they can appreciate its significance for improving the programme delivery, thus motivating the increased survey participation. Examples of such actions – improvements originating from the course evaluations should be presented to both students and faculty.
- A clear strategy related to the flow of information is developed and implemented. In its current form, it is rather confusing where the raw data resides, who has access to it, who analyses it, who interprets the analysis, whether the analysis is communicated to the faculty and what emerges from any such discussion.

Principle 8: Public Information

INSTITUTIONS SHOULD PUBLISH INFORMATION ABOUT THEIR TEACHING AND ACADEMIC ACTIVITIES WHICH IS CLEAR, ACCURATE, OBJECTIVE, UP-TO-DATE AND READILY ACCESSIBLE.

Information on Institution's activities is useful for prospective and current students, graduates, other stakeholders and the public.

Therefore, institutions and their academic units provide information about their activities, including the programmes they offer, the intended learning outcomes, the qualifications awarded, the teaching, learning and assessment procedures used, the pass rates and the learning opportunities available to their students, as well as graduate employment information.

Study Programme Compliance

The School has developed a complete web site (in English and Greek) and maintains active LinkedIn, Facebook and Twitter accounts, all of which are regularly updated with news and activities. All pertinent student-related information is accessible through the School's website.

The School has an extensive network of external stakeholders, and some are actively involved in its activities. All the stakeholders the Panel met are eager to get engaged and help the School achieve its goals. At the same time not all these stakeholders are fully informed on the School's affairs.

The Panel was impressed with the extra-curriculum activities and student engagement in competitions, events and other opportunities to disseminate practices and innovation in chemical engineering related topics.

The Panel finds that overall, the programme fully complies with Principle 8.

Panel Judgement

Principle 8: Public Information	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- The School should consider a more active communication strategy with its constituencies and stakeholders, for example by issuing and emailing periodic newsletters describing School's news, initiatives, awards, success stories, etc. These should also prestigious competitive awards and distinctions received by its individual faculty as well as individual students (namely, beyond distinctions earned by student groups).
- The School should communicate better any formal procedures for student-faculty conflict resolution.
- A site for alumni must be developed that includes information that targets the specific group. Relevant information could be on School strategic initiatives, School success stories in general, including opportunities for visits and engagement.
- Services provided by the large number of specialized instruments existing in the academic unit should be broadly published. This may be a source of additional School income to support student initiatives, equipment renewal, student mobility and industry placements, etc.

Principle 9: On-going Monitoring and Periodic Internal Review of Programmes

INSTITUTIONS SHOULD HAVE IN PLACE AN INTERNAL QUALITY ASSURANCE SYSTEM FOR THE AUDIT AND ANNUAL INTERNAL REVIEW OF THEIR PROGRAMMES, SO AS TO ACHIEVE THE OBJECTIVES SET FOR THEM, THROUGH MONITORING AND AMENDMENTS, WITH A VIEW TO CONTINUOUS IMPROVEMENT. ANY ACTIONS TAKEN IN THE ABOVE CONTEXT SHOULD BE COMMUNICATED TO ALL PARTIES CONCERNED.

Regular monitoring, review and revision of study programmes aim to maintain the level of educational provision and to create a supportive and effective learning environment for students.

The above comprise the evaluation of:

- the content of the programme in the light of the latest research in the given discipline, thus ensuring that the programme is up to date;*
- the changing needs of society;*
- the students' workload, progression and completion;*
- the effectiveness of the procedures for the assessment of students;*
- the students' expectations, needs and satisfaction in relation to the programme;*
- the learning environment, support services and their fitness for purpose for the programme*

Programmes are reviewed and revised regularly involving students and other stakeholders. The information collected is analysed and the programme is adapted to ensure that it is up-to-date. Revised programme specifications are published.

Study Programme Compliance

It appears that extensive internal reviews are conducted annually to evaluate teaching, research, and service activities. A SWOT analysis is also undertaken. Annual reviews help to identify areas of strength and weakness, although progress towards improvements is slow. Even though unstructured in that systematic external feedback is not solicited, these reviews reflect extensive internal deliberations and careful appraisal of current directions and events.

The Panel finds that overall, the programme fully complies with Principle 9.

Panel Judgement

Principle 9: On-going Monitoring and Periodic Internal Review of Programmes	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- As noted above, the programme must proactively solicit input from key stakeholders, including through the formation of an advisory board, which will enable implementing innovation and changes that will improve the student experience. The various annual brainstorming sessions could also be conducted in partnership with faculty from other Schools in NTUA, so that new ideas can be exchanged, and new initiatives seeded.
- The School should institute a clearly articulated action plan with timelines and responsibilities for implementation to facilitate quick and results-oriented action.
- The annual action plan should be clearly communicated in the School's website to all stakeholders, that is, students, faculty, staff, students, alumni, industry and the public.
- The School should engage alumni and industry in discussions for the formulation of all its strategic objectives.

Principle 10: Regular External Evaluation of Undergraduate Programmes

PROGRAMMES SHOULD REGULARLY UNDERGO EVALUATION BY COMMITTEES OF EXTERNAL EXPERTS SET BY HAHE, AIMING AT ACCREDITATION. THE TERM OF VALIDITY OF THE ACCREDITATION IS DETERMINED BY HAHE.

HAHE is responsible for administrating the programme accreditation process which is realised as an external evaluation procedure, and implemented by a committee of independent experts. HAHE grants accreditation of programmes, with a specific term of validity, following to which revision is required. The accreditation of the quality of the programmes acts as a means of verification of the compliance of the programme with the template's requirements, and as a catalyst for improvement, while opening new perspectives towards the international standing of the awarded degrees.

Both academic units and institutions participate in the regular external quality assurance process, while respecting the requirements of the legislative framework in which they operate.

The quality assurance, in this case the accreditation, is an on-going process that does not end with the external feedback, or report or its follow-up process within the Institution. Therefore, Institutions and their academic units ensure that the progress made since the last external quality assurance activity is taken into consideration when preparing for the next one.

Study Programme Compliance

This is the first external accreditation of the programme. The process was conducted in an exemplary fashion, from the submittal of the relevant material to the interview processes. Even under the COVID-19 constraints, the Panel was given the ability to interview in depth and provided with every assistance asked. The program underwent an external evaluation in 2013 and took a number of steps in response to the recommendations of that including: establishing periodic internal reviews; improving the School's website and creating a LinkedIn group; developing a strategic plan, etc. The School is making serious efforts to engage external stakeholders more efficiently.

The Panel finds that overall, the programme fully complies with Principle 10.

Panel Judgement

Principle 10: Regular External Evaluation of Undergraduate Programmes	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

Panel Recommendations

To further solidify and enhance adherence to this Principle, the Panel recommends the following additional action:

- The Panel hopes that this external accreditation will continue into the future. Given that this is a process uniformly applied to all Chemical Engineering programmes in Greece, we also strongly recommend that all related programmes (Aristotle University of Thessaloniki, University of Patras, and NTUA) engage in an open and active coordination of their activities with the goal of improving the Chemical Engineering education across the country, further solidifying Greece's position in the field. It would also be useful for programmes to be asked to provide a list of peer institutions against which their performance would be compared.
- Experience-sharing with Chemical Engineering Departments in Europe, so that best practices can eventually be developed is also strongly recommended.
- Through consultation with industry and alumni the undergraduate curriculum should embrace new technologies and standards such as digitalization and Industry 4.0 (the current trend of automation and data exchange in manufacturing technologies).

PART C: CONCLUSIONS

I. Features of Good Practice

The NTUA School of Chemical Engineering is strong in terms of both teaching and research and is well respected worldwide. The faculty is enthusiastic and dedicated to their mission. The morale in the department is high and the student experience positive. The enthusiasm of the current students, alumni, and employers (of the programme's graduates) was evident in our meetings. The programme graduates pursue successful careers in academia and industry in Greece and abroad. Following its recent external evaluation, the programme has taken bold steps towards improving the students' experience, and it is commended for doing so.

The programme has implemented compliant mechanisms for monitoring and ensuring high quality of work and services. The quality assurance policy that is developed aims to align practices with the strategic objectives the Department has set.

The Panel acknowledges the enormous amount of work that went into collecting the material, preparing a substantial volume of documents and organizing the visit. This clearly indicated that the School of Chemical Engineering at the NTUA is taking the process seriously, is open to suggestions and constructive criticism and is committed to striving for excellence.

II. Areas of Weakness

The Panel identified some areas that require special attention:

- The programme needs to engage its stakeholders (current students, alumni, employers and social partners) actively and systematically. Even though the School is proactively developing actions aiming at improving its curriculum and overall activities, these appear to be primarily driven by the faculty without substantial and critical input and feedback from outside observers. In this sense, the programme needs to develop an outward looking approach. Its stakeholders clearly indicated their willingness to participate in such a process. The School appears to be somewhat inward looking: whereas Chemical Engineering as a discipline offers the possibility of establishing bridges with other Schools and take leadership in creating activities with profound implications (for example, by fostering interactions with the Medical School and spearheading opportunities for developing new focus points, such as Biomedical Engineering, either as parts of the existing programme or as the seed for new ones).
- The programme needs to formalize its internal review mechanisms and importantly, productively engage the totality of the faculty members.
- The programme needs to address an apparent lack of flexibility in curriculum. Although the Panel recognizes that certain actions may be beyond the control of the School of Chemical Engineering, several steps (see our previous Recommendations) are within its means and could be implemented at no cost. The Panel acknowledges several excellent steps the

programme has implemented, following its latest external review, proving that the willingness to further improve is evident.

III. Recommendations for Follow-up Actions

The Panel applauds the School for having implemented several policies aiming at improving the programme delivery. During the visit it became evident that the School needs to operate within limitations imposed by forces above and beyond its control and that its degrees of freedom and ability to implement innovative solutions is often limited. Recognizing these constraints, the Panel limits its recommendations to steps that could be implemented with the means currently available.

- The Panel recommends that the programme establishes an External Advisory Board consisting of industry and academic representatives. This does not need to be a formal entity, if the current framework of operation did not allow it, however, it can be created informally and solicit regular (annual) input from its members.
- The Panel recommends that the programme further implement steps aiming at increasing flexibility in the curriculum. Suggestions include but are not limited to:
 - i. Introducing a “research for credit course” in which students participate in organized research within a lab in lieu of a lecture-based course;
 - ii. Existing courses enrich their content by either introducing targeted cross-disciplinary themes (with the help from faculty from other programmes) or engage alumni/employers as guest lecturers.
- The Panel recommends that systematic and rigorous feedback mechanisms are implemented to assess and evaluate teaching effectiveness and identify corrective actions. The current approaches appear to be *ad hoc* and do not follow a holistic view of the curriculum, but rather address temporary and very course/instructor-specific needs. It is further suggested that a peer committee objectively assesses the programme outputs in its totality and that these results are clearly communicated to the entirety of the faculty members.
- The Panel recommends that teaching and research contributions of the faculty is conducted in a more systematic way and, importantly, result in specific actions in a way that weak(er) performances are improved, whereas strong(er) performances are rewarded. The idea is *not* to penalize colleagues but encourage them to improve their performance. Faculty are not expected to excel in both teaching and research but should be rewarded for improvement in either category.
- The Panel recommends that the School establishes annual “retreats”. These need not be formal events but should be of short duration (one or two days), informal, honest, open discussions, facilitated by an independent/external leader focusing on deliverables, strategic planning, goals and means for achieving these goals. During these retreats, the faculty

should have the opportunity to objectively assess data related to the teaching and research activities, identify a small number of actions and pursue them.

IV. Summary & Overall Assessment

The Principles where full compliance has been achieved are: **1, 4, 5, 6, 7, 8, 9, and 10.**

The Principles where substantial compliance has been achieved are: **2 and 3.**

The Principles where partial compliance has been achieved are: **None.**

The Principles where failure of compliance was identified are: **None.**

Overall Judgement	
Fully compliant	X
Substantially compliant	
Partially compliant	
Non-compliant	

The External Evaluation & Accreditation Panel agrees that this Programme leads to a Level 7 Qualification according to the National & European Qualifications Network (Integrated Master)	YES	NO
	X	

The members of the External Evaluation & Accreditation Panel

Name and Surname

Signature

- 1. Professor Ioannis P. Androulakis (Chair)**
Rutgers, The State University of New Jersey, USA
- 2. Professor Georgios M. Kontogeorgis**
Technical University of Denmark (DTU), Denmark
- 3. Mr. Pantelis Pantelaras**
Manager, Ravago Chemicals, Hellas SA –
Member of the Technical Chamber of Greece, Greece
- 4. Professor Vladimiro Papangelakis**
University of Toronto, Canada
- 5. Professor and Dean of Engineering Yannis Yortsos**
University of Southern California, USA