

**MINISTRY of EDUCATION and SCIENCE of UKRAINE**

**Ternopil Ivan Puluj National Technical University**

**EDUCATIONAL-PROFESSIONAL PROGRAMME**

**«Biomedical engineering»**

**of the first level of higher education**

**on specialty 163 Biomedical engineering**

**Branch of knowledge 16 Chemical and bioengineering**

**Qualification: Expert in Biomedical engineering**

**Approved by Academic Council  
of Ternopil Ivan Puluj National  
Technical University**

Head of Academic council

P.V. Yasniy

(Minutes № 6 of 15.02 2019)

Educational program is launched on «01» 09 2019 p.

**Rector** \_\_\_\_\_ / P.V. Yasniy

(order № 4 of «16» 04 2019)

**Ternopil  
2019**

**Letter of Approval**  
of educational-professional program

Discussed and approved on the Bioengineering Systems Department Meeting  
Meeting Minutes № 7 of « 15 » 02 2019

Head of Department \_\_\_\_\_ Yavorska Ye.B.

Discussed and approved by the Academic council of Applied Information  
Technologies and Electrical Engineering Faculty

Minutes № 6 of « 15 » 02 2019

Head of the Academic council of Department \_\_\_\_\_ Yaskiv V.I.

**The educational-professional program has been developed taking into account the current standards of higher education of Ukraine on Specialty 163 - Biomedical Engineering for the first (Bachelor's) level of higher education (order of MES of Ukraine №1264 від 19.11.18)**

## PREFACE

The Syllabus was developed by the working group consisting of:

1. Yavorskyy B.I. – Sc.D., Prof. of the Radio Systems Department of the Ternopil I.Puluj national technical university;
2. Tkachuk R.A. – Sc.D., Prof. of the Biotechnical Systems Department of the Ternopil I.Puluj national technical university;
3. Yavorska Ye.B. – manager of the working group, Ph.D. in Engineering Science, Associate Prof., Head of the Biotechnical Systems Department of the Ternopil I.Puluj national technical university;
4. Khvostivskyi M.O. – Ph.D. in Engineering Science, Associate Prof. of the Biotechnical Systems Department of the Ternopil I.Puluj national technical university.

Reviews of external stakeholders:

1. Blikhar V.Y., Chief Doctor of communal establishment of Ternopil regional council «Ternopil university hospital».
2. Kmita V.V, medical director on public health service of Ternopil communal city hospital №2.
3. Drosyk M.M., director of Western-Ukrainian specialized medical center «MEBI3».

| <b>1. Bachelor's Training Program in Specialty №163 «Biomedical engineering»</b>  |   |
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| <b>1 – General information</b>  |   |
| <b>Full name of higher educational establishment and a structural subdivision</b>   | Ternopil I.Puluj national technical university, Bioengineering Systems Department   |
| <b>Full name of qualification</b>   | Higher education degree - Bachelor<br>Qualification – expert in Biomedical engineering  |
| <b>Program official name</b>  | Biomedical engineering  |
| <b>Diploma type and number of credits according to the program</b>  | <b>Diploma type:</b> Bachelor's Diploma (Single Honours).<br><b>Number of credits according to the program:</b><br>- based on Complete general secondary education – 240 credits ECTS;<br>- based on the degree «Junior Bachelor» (of educational-qualification level «Junior Specialist») a higher educational establishment is entitled to recognize and credit not more than 60 credits ECTS of the previous educational program of Junior Bachelor (Junior Specialist) training.<br>The total amount of practice covers not less than 4 credits ECTS.<br>Minimum 50% of the educational program credits must provide the acquiring general and special (professional) competences on specialty.<br><b>Duration of study:</b> 3 years 10 months. |
| <b>Accreditation</b>  | MES of Ukraine, Certificate of accreditation HD № 2087407 of June 3, 2014, valid to July 1, 2024.   |
| <b>Cycle/level</b>  | FQ-EHEA – first cycle, EQF LLL – 6 <sup>th</sup> level, HPK – 6 <sup>th</sup> level   |
| <b>Requirements</b>   | Certificate of complete general secondary education or Junior Bachelor diploma.   |
| <b>Language(s) of instruction</b>   | Ukrainian, English  |
| <b>Accreditation</b>  | Till a new educational program is launched.   |
| <b>Permanent Internet address of educational program description</b>  | <a href="https://kaf-bt.tntu.edu.ua/docs/OPP/op163b-2019(ENG).pdf">https://kaf-bt.tntu.edu.ua/docs/OPP/op163b-2019(ENG).pdf</a>   |
| <b>2 - Purpose of the educational-professional program</b>  |   |
| Training of specialists able to solve practical problems and complex specialized tasks in Biomedical engineering characterized by complex and uncertain conditions. |   |
| <b>3 – Characteristics of the educational-professional program</b>  |   |
| <b>Subject area (branch of knowledge), specialty, specialization (if it is available)</b>   | Branch of knowledge - 16 Chemical and bioengineering<br>Specialty - 163 Biomedical engineering  |
| <b>Educational program orientation</b>  | Educational-professional  |
| <b>Main focus of the educational program and specialization</b>   | <b>Study and (or) activity objects:</b> development, production, testing, експлуатація, servicing, repair and certification of medical equipment and biomedical products and biomaterials of medical use; biomedical information processing; technical-information support of medical technologies and systems.<br><b>Study goals:</b> be competent in the field of development, design, production, maintenance, service, expertise and certification of biological and medical instruments and systems, estimation of meeting the requirements of technical regulations, standards of biosecurity and biosafety of biological and medical equipment, biomedical products  |

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|   | <p>and biomaterials of medical use, artificial organs, and also the proper software and IT.</p> <p><b>Theoretical content of subject area:</b> clinical engineering, medical equipment, microelectromechanical systems, medical radiology, medical biotechnologies, biomechanics, robots, biomedical informatics, decision making in medicine; reception, processing, interpretation of bio signals and images of biological objects.</p> <p><b>Methods and techniques:</b> engineering-design methods, bioengineering and medical-engineering methods, modeling, software and information technologies for processing and analysis of biological data, medicine and medical instrument-making.</p> <p><b>Instruments and equipment:</b> biological and medical equipment, biomedical products and biomaterials of medical use, artificial organs, IT-equipment.</p> |
| <b>Special features</b>   | Regular updating enabling to take into account the tendencies of progressing of medical, engineering, and information technologies development. It is mobile by the program of academic mobility «Double diplomas»   |
| <b>4 - Graduates suitability for employment and further education</b> |  |
| <b>Suitability for employment</b>                                     | <p><b>Main positions according to SC 003:2010:</b></p> <p>3111 – expert in medical physics,<br/> 3115 – technician of equipment operation and repair,<br/> 3119 – engineering specification technician,<br/> 3119 – setup and test technician,<br/> 3121 – expert in information technologies (medicine)</p> <p><b>Main positions according to International Standard Classification of Occupations 2008 (ISCO-08):</b></p> <p>2149 – Engineer, biomedical<br/> 5329 – Assistant, medical imaging<br/> 2240 – Assistant, medical: diagnosing and treating patients<br/> 1342 – Administrator, medical<br/> 3255 – Assistant, allied health: physiotherapy<br/> 3255 – Assistant, technical: physiotherapy</p>  |
| <b>Further study</b>  | Graduates can continue the study on the second (Master's) level of higher education. They can obtain some other qualifications in the system of post-graduate studies.   |
| <b>5 – – Teaching and Assessment</b>                                  |  |
| <b>Teaching and study</b>   | The process of study involves both conventional and non-conventional teaching methods, and advanced technologies as well. Conventional methods: lectures, practical and laboratory classes, tutorials; advanced technologies: student-centered study, self-study, problem-oriented study, study through the laboratory practice etc.   |
| <b>Assessment</b>   | Knowledge testing, presentations, reports on laboratory works, reports on practices, control papers, course (project) papers, oral and written examinations, qualification paper or attestation exam.  |
| <b>6 – Program competences</b>  |  |
| <b>Integral competence</b>  | Be able to solve practical problems and complex specialized tasks characterized by complex and uncertain conditions and involving the use of theories and methods of chemical, biological and medical engineering in the field of biomedical engineering or in the study process.  |

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| <b>General competences (GC)</b>                              | GC1.  | Ability in applying theoretical knowledge in practice.  |
|  | GC2.  | Knowledge and understanding the subject area and professional activity.   |
|  | GC3.  | Be able to speak and write in state language.   |
|  | GC4.  | Be able to apply information and communication technologies.  |
|  | GC5.  | Be able to conduct research on proper level.  |
|  | GC6.  | Be able to search, process and analyze information from different sources.  |
|  | GC7.  | Be able to generate new ideas (creativity).   |
|  | GC8.  | Be able to make reasonable decisions.   |
|  | GC9.  | Be able to communicate with representatives of other professional groups of various levels (with experts in other fields of knowledge or economic activity).  |
|  | GC10. | Have skills of safe activity.   |
|  | GC11. | Be able to assess and assure the quality of the work done.  |
|  | GC12. | Be able to implement rights and duties as a member of society; comprehension of value of civil (free democratic) society and the necessity of its sustainable development, supremacy of law, human rights and freedoms in Ukraine.  |
|  | GC13. | Be able to store and add moral, cultural, scientific values and achievements of society due to the understanding of history and laws of development of the subject area, its place in the general system of knowledge about nature and society and in the development of the society, engineering and technologies, apply different kinds and forms of physical activity for active rest and healthy lifestyle. |
| <b>Special (professional, subject area) competences (SC)</b> | SC1.  | Be able to use the engineering software aimed at scientific research conducting, results analysis, processing and presentation, and also at computer-aided design of medical devices and systems.   |
|  | SC2.  | Be able to provide engineering-technical expertise in planning, development, assessment and specification of medical equipment.   |
|  | SC3.  | Be able to master and apply new methods and tools of analysis, modeling, design and optimization of medical devices and systems.  |
|  | SC4.  | Be able to provide technical and functional characteristics of systems and facilities used in medicine and biology (in disease prevention, diagnostics, treatment and rehabilitation).  |
|  | SC5.  | Be able to use physical, chemical, biological and mathematical methods in analysis, modeling of living organisms and bioengineering systems functioning.  |

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|  | SC6.  | Ability in efficient using tools and methods of analysis, design, calculations and tests at the development of biomedical products and services.   |
|  | SC7.  | Ability in planning, designing, developing, installing, applying, maintaining, servicing, controlling and repair coordinating the devices, equipment and systems for disease preventing, diagnostics, treatment and rehabilitation used in hospitals and scientific-research institutes. |
|  | SC8.  | Be able to carry out some research and observations on interaction of biological, natural and artificial systems (prosthetic devices, artificial organs etc.).   |
|  | SC9.  | Be able to identify, set and solve some engineering problems dealing with interaction of living and nonliving systems.   |
|  | SC10. | Be able to apply principles of construction of modern automated control systems of medical devices manufacture, their engineering, algorithm, information and software support.  |

### **7 – Program learning outcomes**

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| Normative component | PLO1. | Apply knowledge of fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering drawing, mechanics, material strength and resistance, fluid mechanics, electronics, informatics, signal and image receiving and analysis, automatic control, system analysis and methods of decision making on the level necessary to solve problems of biomedical engineering. |
|                     | PLO2  | Come to logic conclusions and substantiated recommendations on assessment, use and implementation of biotechnical, medical-technical and bioengineering methods and facilities.  |
|                     | PLO3  | Manage complex actions or projects, take responsibility for engineering decisions making under unpredictable conditions.   |
|                     | PLO4  | Be able to apply statements of regulatory-technical documents specifying the procedure of product certification, production attestation.   |
|                     | PLO5  | Be able to use databases, mathematical and software support in data processing and computer modeling of bioengineering systems.  |
|                     | PLO6  | Be able to communicate with professionals in the field of health care in state and foreign (English or another EU official) languages and understand their requirements to biomedical products and services.   |
|                     | PLO 7 | Provide engineering support, servicing and other technical support at operation of laboratory-analytical equipment, medical diagnostic and therapeutic complexes and systems, be able to write standard documents of different types of work according to Technical regulation of medical products.  |

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|   | PLO 8   | Understand theoretical and practical approaches to development and control of medical equipment and facilities.  |
|   | PLO 9   | Understand theoretical and practical approaches to development and use of artificial biological and bioengineering objects and materials of medical use.   |
|   | PLO10   | Be able to plan, organize, direct and control medical-technical and bioengineering systems and processes.  |
|   | PLO11   | Provide control of quality and operating conditions of medical equipment and materials of medical use, artificial organs and prosthetic devices.   |
|   | PLO12   | Give recommendations on choosing the proper equipment used in diagnostics and treatment.   |
|   | PLO13   | Be able to analyze signals transmitted from organs to the devices and process diagnostic information.  |
|   | PLO14   | Be able to analyze the level of meeting the current global standards and to assess the decisions, set tasks on development of automated control systems taking into account possibilities of advanced software and hardware as for medical equipment automation. |
|   | PLO15   | Be able to set tasks on development of automated control systems taking into account possibilities of advanced software and hardware in medical equipment automation.  |
|   | PLO16   | Have a skill in choosing and recommending the proper medical equipment and biomaterials to equip medical establishments and provide the main stages of technological process of diagnostics, disease prevention and treatment.                                   |
|   | PLO17   | Be able to use computer-aided design systems to develop technological and hardware circuit of medical; devices and systems.  |
|   | PLO18   | Apply knowledge of chemistry and bioengineering for development, synthesis and use of artificial bioengineering and biological objects.  |
| <b>8 – Program implementation resources</b> |   |  |
| <b>Staff assistance</b>                     | <p>All academic staff involved in the profession-oriented courses teaching has scientific degrees and/or academic status and they meet the license requirements.</p> <p>The program meets the requirements of staff assistance in educational activity assurance in the field of higher education concerning the educational level “Bachelor” according to the current laws of Ukraine (Statement of Cabinet of Ministers of Ukraine of 30.12.2015 № 1187 amended in 23.05.2018 № 347).</p>   |  |
| <b>Materials and facilities</b>             | <p>Materials and facilities of the Bioengineering systems Department are a part of the material-technical base of the Faculty of Applied Information Technologies and Electrical Engineering of TNTU. All laboratory and practical classes of non-professional courses are delivered in the classroom fund and material-technical base of the university. Professional laboratory and practical classes are given in special laboratories of the Bioengineering systems Department in building №9 of TNTU named after Ivan Puluj.</p> |  |



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| <b>Information support and teaching – learning materials</b> | <p>Use of virtual learning environment of TNTU, author's papers of the academic staff, library-information resources, resources of the scientific-technical library of the university.</p> <p>The e-learning system ATutor provides an access to the materials in English and Ukrainian within the educational program, presentations, tests, video material, other components of e-learning. The platform ATutor has been developed for distance access to the teaching-learning materials which combines materials of lectures, practical classes, instructions and tasks to self-study with possible team work in e-learning courses, materials of e-catalogue of the library, repository and references on external learning courses.</p>  |
| <b>9 – Academic mobility</b>                                 |  |
| <b>National credit mobility</b>                              | Agreements of academic mobility, of double diplomas awarding have been signed  |
| <b>International credit mobility</b>                         | <p>In 20016 some new agreements of cooperation have been signed with: Lublin University of technology (Poland); Opole University of technology (Poland); Jan Amos Komieński State school of higher vocational education (Poland); Shota Rustaveli Batumi state university (Georgia); Sopot high school (Poland); Czestochowa University of technology (Poland); Company "Television communications" (Lithuania); Company "II Autoezeruona" (Lithuania); Kaunas University of technology (Lithuania); Gabrovo technical university (Bulgaria); Wroclaw university of economics (Poland); University of Informatics and Applied Knowledge in Łód. (Poland); University of Zylina (Slovak Republic).</p> <p>Participation in the international program of EU Horizont 2020 and international educational programs of EU Tempus / Erasmus+</p> |
| <b>Foreign students training</b>                             | Main course modules of the program are provided with educational and methodical complex for foreign students both in English and Ukrainian.  |

## 2. List of EPP educational components and their logical sequence

### 1.1. List of educational components

| Code n/a   | Components of the educational program<br>(academic disciplines, course projects (works), practices, qualification works) | Number of credits | Form of final control   |
|--|--|-------------------|-------------------------|
| 1  | 2  | 3                 | 4                       |
| <b>Mandatory components of the educational program</b> |  |                   |                         |
| RC1  | Higher Mathematics   | 13,5              | Examination             |
| RC2  | General chemistry  | 4                 | Examination             |
| RC3  | Language of Instruction (English)  | 6                 | Examination             |
| RC4  | History and Culture of Ukraine   | 5                 | Examination             |
| RC5  | Technoecology and Civil Safety   | 4                 | Credit                  |
| RC6  | Ukrainian for Specific Purposes  | 5                 | Examination             |
| RC7  | Physics  | 12,5              | Examination             |
| RC8  | Philosophy   | 4                 | Examination             |
| RC9  | Analogue Circuitry   | 4,5               | Examination             |
| RC10   | Human Anatomy, Physiology and Pathology  | 6,5               | Credit                  |
| RC11   | Life Safety and Fundamentals of Labor Protection   | 4                 | Examination             |
| RC12   | Biomedical Engineering   | 4                 | Examination             |
| RC13   | Biophysics   | 5                 | Examination             |
| RC14   | Biochemistry   | 4                 | Credit                  |
| RC15   | Diagnostic and Therapeutic Systems   | 4                 | Credit                  |
| RC16   | Electronic Devices   | 4                 | Credit                  |
| RC17   | Engineering and Computer Graphics  | 4                 | Examination             |
| RC18   | Laboratory Analytical Instruments  | 4                 | Credit                  |
| RC19   | Materials Science and Biocompatibility of Materials  | 4                 | Credit                  |
| RC20   | Medical Devices, Complexes and Systems   | 4                 | Credit                  |
| RC21   | Metrology  | 4,5               | Credit                  |
| RC22   | Microprocessor Equipment   | 4                 | Credit                  |
| RC23   | Fundamentals of biomechanics   | 4                 | Credit                  |
| RC24   | Fundamentals of Biomedical Apparatus Design  | 4                 | Examination             |
| RC25   | Fundamentals of Circuit and Signals Theory   | 9                 | Examination, Coursework |
| RC26   | Fundamentals of Technology and Manufacturing of Biomedical Apparatus   | 4                 | Examination             |
| RC27   | Applied Mechanics  | 4,5               | Examination             |
| RC28   | Biomedical Engineering Principles  | 4                 | Credit                  |
| RC29   | Programming and Algorithmic Languages  | 6                 | Credit                  |
| RC30   | Digital Circuitry  | 4                 | Examination             |
| RC31   | Practical Training   | 3                 | Differentiated credit   |
| RC32   | Engineering and Production Practical Training  | 6                 | Differentiated credit   |
| RC33   | Industrial Internship  | 3                 | Differentiated credit   |
| RC34   | Professional practice  | 6                 | Differentiated credit   |
| RC35   | Professional exam  | 1,5               | Examination             |
| <b>The total amount of mandatory components</b>        |  | <b>173,5</b>      |                         |

| 1  | 2                      | 3           | 4                          |
|--|------------------------|-------------|----------------------------|
| <b>Selective components of the educational program</b> |                        |             |                            |
| SC1  | Selective component 1  | 10          | Examination                |
| SC2  | Selective component 2  | 3           | Credit                     |
| SC3  | Selective component 3  | 3           | Credit                     |
| SC4  | Selective component 4  | 4           | Examination                |
| SC5  | Selective component 5  | 4           | Examination,<br>Coursework |
| SC6  | Selective component 6  | 5,5         | Examination                |
| SC7  | Selective component 7  | 4           | Examination                |
| SC8  | Selective component 8  | 4           | Credit,<br>Coursework      |
| SC9  | Selective component 9  | 5,5         | Examination,<br>Coursework |
| SC10   | Selective component 10 | 3           | Credit                     |
| SC11   | Selective component 11 | 4           | Credit,<br>Coursework      |
| SC12   | Selective component 12 | 4           | Examination,<br>Coursework |
| SC13   | Selective component 13 | 4,5         | Examination,<br>Coursework |
| SC14   | Selective component 14 | 5           | Examination                |
| SC15   | Selective component 15 | 3           | Credit                     |
| <b>The total amount of sample components</b>           |                        | <b>66,5</b> |                            |
| <b>TOTAL VOLUME OF THE EDUCATIONAL PROGRAM</b>         |                        | <b>240</b>  |                            |

### 3. Form of attestation

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| <b>Forms of Bachelor's attestation</b>         | The attestation of applicants of higher education in the specialty "Biomedical Engineering" can be carried out in the form of: <ul style="list-style-type: none"><li>- public defense of Qualification work;</li><li>- attestation exam (exams).</li></ul>  |
| <b>Requirements to the Qualification paper</b> | <p>Qualification paper must involve solving of a complex special engineering-technical task or a practical problem in the field of biomedical engineering characterized by complex and uncertain conditions and using theories and methods of chemical, biological and medical engineering.</p> <p>Qualification paper must not contain any academic plagiarism, fabrication, falsification.</p> <p>Qualification paper should be released on the official site and/or in the repository of the higher education institution or its subdivision.</p> <p>Making Qualification papers containing some information of restricted access available to the public must meet the requirements of the current law.</p> |

#### 4. Matrix of accordance of program competences to educational program components

| Програмні<br>результати<br>навчання | Компетентності                |                         |      |      |      |      |      |      |      |      |       |       |       |       |                                    |      |      |      |      |      |      |      |      |       |
|-------------------------------------|-------------------------------|-------------------------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|------------------------------------|------|------|------|------|------|------|------|------|-------|
|                                     | Інтегральна<br>компетентність | Загальні компетентності |      |      |      |      |      |      |      |      |       |       |       |       | Спеціальні (фахові) компетентності |      |      |      |      |      |      |      |      |       |
|                                     |                               | GC 1                    | GC 2 | GC 3 | GC 4 | GC 5 | GC 6 | GC 7 | GC 8 | GC 9 | GC 10 | GC 11 | GC 12 | GC 13 | SC 1                               | SC 2 | SC 3 | SC 4 | SC 5 | SC 6 | SC 7 | SC 8 | SC 9 | SC 10 |
| PLO 1                               | *                             | *                       |      | *    | *    |      |      |      |      | *    |       | *     | *     | *     | *                                  |      | *    |      |      |      |      |      |      | *     |
| PLO 2                               | *                             |                         | *    | *    |      |      | *    | *    | *    | *    |       | *     | *     | *     |                                    | *    | *    | *    | *    | *    |      |      |      |       |
| PLO 3                               | *                             |                         |      | *    |      |      | *    |      | *    | *    |       | *     | *     | *     |                                    |      |      |      |      |      | *    |      | *    |       |
| PLO 4                               | *                             | *                       | *    | *    |      |      |      |      | *    |      |       | *     | *     | *     |                                    | *    |      |      |      |      | *    |      |      |       |
| PLO 5                               | *                             | *                       | *    | *    | *    | *    | *    | *    | *    |      |       |       | *     | *     | *                                  |      | *    |      | *    | *    | *    | *    | *    | *     |
| PLO 6                               | *                             | *                       | *    | *    | *    | *    | *    | *    | *    | *    | *     | *     | *     | *     | *                                  | *    | *    | *    | *    | *    | *    | *    | *    | *     |
| PLO 7                               | *                             | *                       | *    | *    | *    | *    | *    | *    | *    | *    | *     | *     | *     |       | *                                  |      | *    |      |      |      | *    |      |      | *     |
| PLO 8                               | *                             | *                       | *    | *    | *    | *    | *    | *    | *    | *    | *     | *     | *     | *     | *                                  | *    | *    |      | *    | *    |      |      |      | *     |
| PLO 9                               | *                             | *                       | *    |      | *    | *    | *    | *    | *    | *    |       |       | *     | *     |                                    | *    |      | *    |      |      |      | *    | *    |       |
| PLO 10                              | *                             |                         | *    | *    |      |      |      | *    | *    |      |       | *     | *     | *     | *                                  | *    | *    | *    | *    | *    | *    | *    | *    | *     |
| PLO 11                              | *                             | *                       | *    | *    |      |      |      |      | *    | *    | *     | *     | *     |       | *                                  |      | *    |      |      |      |      | *    | *    |       |
| PLO 12                              | *                             | *                       | *    | *    |      |      |      |      | *    | *    | *     | *     | *     |       |                                    |      | *    |      |      |      | *    |      | *    |       |
| PLO 13                              | *                             | *                       | *    | *    | *    | *    | *    | *    | *    |      |       |       | *     | *     | *                                  |      | *    | *    |      |      |      | *    |      | *     |
| PLO 14                              | *                             | *                       | *    | *    | *    | *    | *    | *    | *    | *    | *     | *     | *     | *     | *                                  | *    | *    |      | *    | *    |      |      |      | *     |
| PLO 15                              | *                             | *                       | *    | *    |      | *    | *    | *    | *    | *    | *     | *     | *     | *     | *                                  |      | *    |      |      |      | *    |      |      | *     |
| PLO 16                              | *                             | *                       | *    | *    |      |      |      |      | *    | *    | *     | *     | *     | *     | *                                  |      | *    | *    | *    | *    | *    |      |      |       |
| PLO 17                              | *                             | *                       | *    | *    |      | *    | *    | *    | *    | *    | *     | *     | *     | *     | *                                  |      | *    |      |      |      | *    |      |      | *     |
| PLO 18                              | *                             | *                       | *    | *    |      |      |      |      | *    | *    | *     | *     | *     | *     |                                    |      | *    | *    | *    | *    |      | *    | *    |       |

