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CONFERENCE ON INTERNATIONAL SCIENTIFIC DEVELOPMENTS: INSIGHTS INTO MODERN SCIENCE AND INNOVATIVE PRACTICES

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GAZ GENERATORI REAKSIYA ZONASIDAGI HARORATNI MASOFADAN O‘LCHASH VA MONITORING QILISH TIZIMINI YARATISH

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Kalit so‘zlar:
Gaz generatori, termoliz, piroliz, termojuftlik, mikrokontroller, harorat monitoringi, masofadan o‘lchash, IoT.

Annotatsiya. Ushbu tezisda termoliz va piroliz rejimida ishlaydigan gaz generatorining reaksiya zonasidagi haroratni masofadan o‘lchash va monitoring qilish tizimini yaratish masalalari ko‘rib chiqiladi. Termojuftlik, MAX31855 raqamli konvertori va ESP32 mikrokontrolleri asosidagi o‘lchash tizimining strukturaviy sxemasi taklif etilgan, harorat datchiklarining xususiyatlari taqqoslangan hamda ma’lumotlarni simsiz uzatish va real vaqt rejimida vizualizatsiya qilish imkoniyatlari tahlil qilingan. Taklif etilayotgan tizim jarayon haroratini uzluksiz nazorat qilish, avariya holatlarini erta aniqlash va gazifikatsiya samaradorligini oshirishga xizmat qiladi.

Ключевые слова:
Газогенератор, термолиз, пиролиз, термопара, микроконтроллер, мониторинг температуры, дистанционное измерение, IoT.

Аннотация: В данной работе рассматриваются вопросы создания системы дистанционного измерения и мониторинга температуры в реакционной зоне газогенератора, работающего в режимах термолиза и пиролиза. Предложена структурная схема измерительной системы на основе термопары, цифрового преобразователя MAX31855 и микроконтроллера ESP32, проведено сравнение характеристик датчиков температуры, проанализированы возможности беспроводной передачи данных и визуализации в реальном времени. Предлагаемая система позволяет непрерывно контролировать температуру процесса, своевременно выявлять аварийные ситуации и повышать эффективность газификации.

Keywords:
Gas generator, thermolysis, pyrolysis, thermocouple, microcontroller, temperature monitoring, remote measurement, IoT.

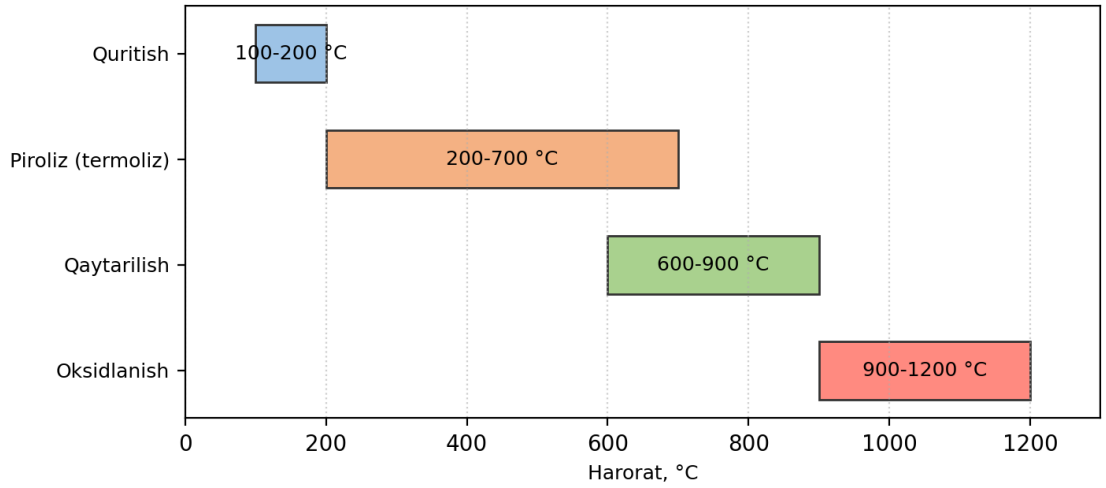
Annotation: This paper considers the development of a remote temperature measurement and monitoring system for the reaction zone of a gas generator operating in thermolysis and pyrolysis modes. A block diagram of a measuring system based on a thermocouple, a MAX31855 digital converter and an ESP32 microcontroller is

proposed, the characteristics of temperature sensors are compared, and the possibilities of wireless data transmission and real-time visualization are analyzed. The proposed system provides continuous control of the process temperature, early detection of emergency situations and improved gasification efficiency.

Kirish: Bugungi kunda qayta tiklanuvchi energiya manbalariga bo‘lgan qiziqishning ortishi biomassa va qattiq organik chiqindilarni termik konversiyalash texnologiyalarini rivojlantirishni taqozo etmoqda. Gaz generatorlari (gazifikatorlar) qattiq yoqilg‘ini termoliz va piroliz jarayonlari orqali yonuvchi gazga aylantirib beradi. Bunday qurilmalarda jarayonning sifati va xavfsizligi, eng avvalo, reaksiya zonasidagi haroratga bog‘liq bo‘ladi.

Reaksiya zonasida harorat yuzlab gradusdan 1000 °C dan ortiq qiymatlargacha o‘zgaradi, bunda kuchli issiqlik, chang va smolali birikmalar mavjud bo‘ladi. Bunday sharoitda haroratni qo‘lda nazorat qilish yetarli aniqlik va xavfsizlikni ta’minlamaydi. Shu sababli haroratni masofadan o‘lchash va monitoring qilish imkonini beruvchi mikrokontrollerli elektron tizimni yaratish dolzarb vazifa hisoblanadi. Mazkur ishda shunday tizimning tuzilishi, datchiklarni tanlash va ma’lumotlarni uzatish masalalari ko‘rib chiqiladi.

Asosiy qism: Gaz generatorida jarayon ketma-ket joylashgan bir nechta zonada kechadi. Ularning har biri o‘ziga xos harorat oralig‘iga ega bo‘lib, bu oraliqlar 1-rasmda keltirilgan. Termoliz va piroliz zonasida yoqilg‘i kislorod yetishmaydigan muhitda parchalanadi va uchuvchi moddalar ajralib chiqadi, oksidlanish zonasida esa eng yuqori harorat kuzatiladi.



1-rasm. Gaz generatori zonalaridagi tipik harorat oraliqlari (adabiyotlar asosida umumlashtirilgan)

Harorat datchigini tanlash

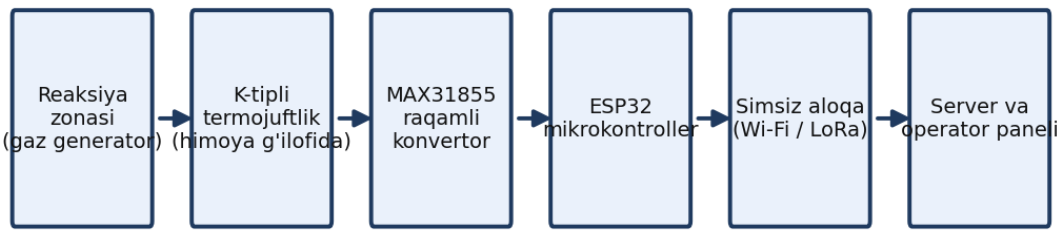
Reaksiya zonasida o‘lchash uchun datchik keng harorat diapazoniga, mexanik va kimyoviy chidamlilikka ega bo‘lishi kerak. 1-jadvalda asosiy datchik turlari taqqoslangan. Tahlil natijalariga ko‘ra, narxi, diapazoni va chidamliligi nuqtai nazaridan K-tipli (xromel–alumel) termojuftlik eng maqbul tanlov hisoblanadi; juda yuqori aniqlik talab etilganda S-tipli termojuftlikdan foydalanish mumkin.

1-jadval. Harorat datchiklarining taqqosiy tavsifi

Datchik turi	Taxminiy diapazon	Afzalligi	Kamchiligi
K-tipli termojuftlik	−200…+1260 °C	Arzon, keng diapazon, mustahkam	Sovuq uch kompensatsiyasi kerak, aniqlik ±2…3 °C
S-tipli termojuftlik	0…+1600 °C	Yuqori aniqlik va barqarorlik	Qimmat
Pt100 (termorezistor)	−200…+600 °C	Yuqori aniqlik	Reaksiya zonasi uchun diapazoni yetarli emas
Infraqizil pirometr	0…+1800 °C (modelga qarab)	Kontaktsiz o‘lchash	Chang, tutun va emissivlikka sezgir

Tizimning tuzilishi

Taklif etilayotgan tizim 2-rasmda ko‘rsatilgan bloklardan iborat. Reaksiya zonasiga himoya g‘ilofiga o‘rnatilgan termojuftlik joylashtiriladi. Uning kuchsiz signali MAX31855 mikrosxemasi orqali raqamli kodga aylantiriladi; mikrosxema sovuq uch kompensatsiyasini ham amalga oshiradi va SPI interfeysi orqali ESP32 mikrokontrolleriga ulanadi. Mikrokontroller o‘lchangan qiymatlarga dastlabki ishlov beradi va Wi-Fi yoki LoRa orqali serverga uzatadi, operator esa natijalarni veb-panel yoki mobil ilova orqali kuzatadi.



2-rasm. Haroratni masofadan o‘lchash va monitoring tizimining strukturaviy sxemasi

Dasturiy ta’minot quyidagi funksiyalarni bajaradi: datchikni davriy so‘rash (taxminan 1 s), medianali filtr yordamida shovqin va tasodifiy sakrashlarni yo‘qotish, zonalar bo‘yicha chegaraviy qiymatlarni solishtirish, ogohlantirish signalini shakllantirish hamda ma’lumotlarni vaqt belgisi bilan saqlash. Uzoq masofalarda o‘lchash zarur bo‘lganda kompensatsion kabeldan, galvanik ajratishdan yoki RS-485 interfeysidan foydalanish tavsiya etiladi.

2-jadval. Taklif etilayotgan tizimning asosiy parametrlari

Parametr	Qiymat
O‘lchash diapazoni	0…1200 °C
O‘lchash kanallari soni	4 (kengaytirish mumkin)
Raqamli konvertor ruxsati	0,25 °C (MAX31855)
So‘rov davri	1 s
Ma’lumot uzatish usuli	Wi-Fi / LoRa
Ogohlantirish	Chegaraviy qiymatdan oshganda signal va xabar

Tizimning afzalligi shundaki, u operatorni xavfli zonadan uzoqlashtiradi, jarayon tarixini saqlaydi va harorat o‘zgarish tendensiyasi bo‘yicha jarayonning buzilishini oldindan aniqlash imkonini beradi. Kelgusida olingan ma’lumotlar asosida adaptiv PID yoki noravshan mantiqli boshqaruv algoritmlarini joriy etish mumkin.

Xulosa: Gaz generatori reaksiya zonasidagi haroratni masofadan o‘lchash va monitoring qilish tizimini mikrokontrollerli elektron qurilmalar asosida yaratish jarayon xavfsizligi va samaradorligini oshirishning samarali yo‘li hisoblanadi. K-tipli termojuftlik, MAX31855 konvertori va ESP32 mikrokontrolleri asosidagi yechim arzonligi, ixchamligi va kengaytirish imkoniyati bilan ajralib turadi. Keyingi tadqiqotlar tizimni real gaz generatorida sinash, o‘lchash xatoligini baholash va avtomatik boshqaruv algoritmlari bilan integratsiyalashga qaratiladi.

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TABLE OF CONTENTS

1.	**Гелдибаев Бегенч Егендурдыевич**, ОБЗОР ИССЛЕДОВАНИЙ VISION-LANGUAGE MODELS ДЛЯ ЗАДАЧ ВИЗУАЛЬНОГО РАСПОЗНАВАНИЯ	**5**
2.	**Ergashov Ziyodullo Bobir og'li**, O‘ZBEKISTON HUDUDIDA QADIMGI SIVILIZATSIYALARNING SHAKLLANISHI	**10**
3.	**L.K. Jamolova, H.Sh.Sharifov**, FACTORS AFFECTING THE EFFICIENCY OF SOLAR PANELS	**15**
4.	**X.R. G‘afforov**, DIAGNOSIS OF THE LEVEL OF FORMATION OF PROFESSIONAL COMPETENCIES OF STUDENTS OF TECHNICAL HIGHER EDUCATION INSTITUTIONS	**18**
5.	**Sag‘dullayeva Zuhra Ne’matulla qizi**, KOMPENSATSIYAVIY YONDASHUV ASOSIDA OLIY TA’LIM MUASSASALARIDA FRANSUZ TILINI O‘QITISH METODIKASI	**22**
6.	**Astanakulov Ulugbek Khusanovich**, PEDAGOGICAL APPROACHES TO TEACHING WRITING IN EFL: A COMPARATIVE THEORETICAL ANALYSIS	**28**
7.	**Нуруллаева Фарангиз Толибжон кизи**, КОГНИТИВНО-СЕМАНТИЧЕСКИЕ МЕХАНИЗМЫ КОНЦЕПТУАЛЬНОЙ МЕТАФОРЫ В СОВРЕМЕННОМ РУССКОМ ЯЗЫКЕ	**32**
8.	**Zikirullayeva Nilufar Dilmurod kizi**, THE IMPORTANCE OF GREEN ECONOMY IN WORLD ECONOMIC DEVELOPMENT	**35**
9.	**Mansurova Rayxona Adham qizi, S. Chimpo‘latova**, XX ASR MISR ADABIYOTINING YIRIK NAMOYANDASI YOZUVCHI YAHYO HAQQINING HAYOTI VA IJODI	**40**
10.	**Abdiqodirova O'g`iloy Abdirayim qizi**, RAQAMLI TA’LIM TEXNOLOGIYALARI YORDAMIDA TALABALARDA MUSTAQIL TA’LIM KO‘NIKMALARINI RIVOJLANTIRISHNING PEDAGOGIK ASOSLARI	**44**
11.	**Kodirova Dilfuza**, SATIRICAL ELEMENTS IN THE POLITICAL AND SOCIAL CRITICISM OF JONATHAN SWIFT	**49**
12.	**Meliyeva Sevara Faxriddin qizi**, THE CONNOTATIVE FIELD OF SUBSTANDARD UNITS IN UZBEK AND ENGLISH	**52**
13.	**Муратбаева Азиза Даулетбаевна**, СПОСОБЫ И МОДЕЛИ ОККАЗИОНАЛЬНЫХ ПРЕОБРАЗОВАНИЙ В ПЕРИОДИЧЕСКОЙ ПЕЧАТИ	**57**
14.	**Rustamov Akbar Askarovich**, TAKING INTO ACCOUNT THE AGE-RELATED CHARACTERISTICS OF 6–7-YEAR-OLD CHILDREN IN THE PROCESS OF INDIVIDUALIZED CHESS INSTRUCTION	**62**
15.	**Махамадалиева Н.Р., Хамидуллаева Ф.И., Бабаджанова Н.Т.**, ЦИТОКИНОВЫЙ ПРОФИЛЬ СМЕШАННОЙ СЛЮНЫ КАК МАРКЕР РИСКА РАЗВИТИЯ ГИНГИВИТА У ПОДРОСТКОВ ПОСЛЕ ПЕРЕНЕСЁННОЙ COVID-19 ИНФЕКЦИИ	**70**

16.	**Salimov Nurali Ramazon o`g`li**, O‘ZBEKISTONDA SUN`IY INTELLEKT TEXNOLOGIYALARIDAN FOYDALANGAN HOLDA KIBERXAVFSIZLIKNI RIVOJLANTIRISH ISTIQBOLLARI	**73**
17.	**Muxammedova Dilshoda Nodir qizi**, PUBLITSISTIK USLUBDA QO‘LLANUVCHI TOPONIMIK PERIFRAZALARNING SINONIMIK XUSUSIYATLARI	**78**
18.	**Safoyev Nodirjon Nematjon o‘g‘li**, O‘ZBEK TILIDAGI AVTOMATIK TARJIMA SIFATINI OSHIRISH UCHUN TAKOMILLASHTIRILGAN BERT YONDASHUVLARI	**84**
19.	**Mustafayeva Matlubaxon Ilhomjon qizi**, SPECIFIC FEATURES OF IDIOMS IN ENGLISH AND RUSSIAN LITERARY TEXTS	**88**
20.	**Умаров Бобурбек Носир угли, Жураев Ахтам Хамроевич**, ИССЛЕДОВАНИЕ ОСНОВНЫХ ПОКАЗАТЕЛЕЙ ВЕРМИКУЛИТА В КАЧЕСТВЕ АДСОРБЕНТА	**93**
21.	**Нуров С.С., Мусаев А.Х.**, МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ГАЗОПЕРЕКАЧИВАЮЩЕГО АГРЕГАТА ДЛЯ СИНТЕЗА СИСТЕМЫ АВТОМАТИЧЕСКОГО УПРАВЛЕНИЯ В СРЕДЕ MATLAB/SIMULINK	**95**
22.	**Nazarov Alimardan Kamol o’g’li**, OTA-ONA VA O‘SMIR MUNOSABATLARINI O’GANISHGA OID METODIKALARINING ILMIY ASOSLARI	**100**
23.	**Hamidova Nozima Sirojiddin qizi, Temirova Matlab Ibodovna**, ISHLATILGAN O‘SIMLIK YOG‘LARINI QAYTA ISHLASH ORQALI QO‘SHIMCHA QIYMATLI MAHSULOTLAR OLISHNING TEXNOLOGIK IMKONIYATLARI	**102**
24.	**Azamat Orunbayev**, THE EFFECTS OF AEROBIC-STEP AND PILATES EXERCISES ON STRENGTH, FLEXIBILITY, ANAEROBIC POWER, BALANCE, AND BODY COMPOSITION	**106**
25.	**Saminbayev Mashhurbek Ravshanbek o‘g‘li, Qobulov Boburmirzo Ulug‘bek o‘g‘li**, ANIME YOSHLAR DUNYOQARASHIDA O‘LIM VA HAYOT FALSAFASINING TRANSFORMATSIYASI	**112**
26.	**Yuldasheva Sevara Bakhodir kizi**, THE SPECIFIC FEATURES OF THE OGHUZ LANGUAGE IN WRITTEN MONUMENTS OF THE 11TH-12TH CENTURIES	**116**
27.	**Журакулов Санжар**, КРИТЕРИИ И ПОКАЗАТЕЛИ ОЦЕНКИ ЭФФЕКТИВНОСТИ САМОСТОЯТЕЛЬНОГО ОБУЧЕНИЯ ФИЗИКЕ СТУДЕНТОВ ТЕХНИЧЕСКИХ НАПРАВЛЕНИЙ НА ОСНОВЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ	**121**
28.	**Yuldoshov Elchinbek Qosim ugli, Khayitov A.A.**, DISPENSARY EXAMINATION FOR ENT DISEASES	**124**
29.	**Nuraliyev Islom Saidaliyevich**, BO‘LAJAK O‘QITUVCHILARDA TESTOLOGIK KOMPETENTLIKNI RIVOJLANTIRISHNING AMALIY HOLATI VA XORIJIY TAJRIBANING QIYOSIY-PEDAGOGIK TAHLILI	**129**
30.	**Qazoqov Jo‘rabek Roziqovich, Uvayzov Saidjon Komilovich, Mizomov Muhammad Saydulla o`g`li**, OPERATOR INTERFEYSLARINI ISHLAB CHIQISHDA ERGONOMIK YONDASHUVLAR	**135**

31.	**Maxkamova Xilolaxon Xasanxon qizi**, FORUM FOCUSED INSTROCTION IN COMUNICATIVE ENGLISH CLASSES: BENEFITS AND LIMITATIONS	**139**
32.	**Boboyeva Zebo Hasanovna**, OLIY TA'LIM TIZIMIDA PEDAGOGIK MADANIYATNI SHAKLLANTIRISHNING INNOVATSION YONDASHUVLARI	**142**
33.	**Yarasheva Dilnoza Ismoil qizi**, METHODOLOGY FOR DETERMINING FLEXIBILITY IN FEMALE HANDBALL PLAYERS	**147**
34.	**Serikbayeva Dina Altinbayeva**, BOSHLANG‘ICH SINFLARDA MATEMATIK TAFAKKURNI RIVOJLANTIRISHDA INNOVATSION YONDASHUVLAR	**151**
35.	**Atamurodova Guljon Komilovna, Abdullayeva Maryambibi Jumaniyazovna**, TALABALARDA IJTIMOIY FAOLLIKNI INNOVATSION PEDAGOGIK TEXNOLOGIYALAR ASOSIDA RIVOJLANTIRISHNING METODIKASI	**155**
36.	**Abdullayva Mohlaroyim Nodirbek qizi, Rustamova Fotima Umidjon qizi, Rustamova Zuhra Umidjon qizi**, THE INFLUENCE OF DIET ON OVULATORY FUNCTION IN WOMEN AFTER OVARIAN CAUTERIZATION: A LITERATURE REVIEW	**159**
37.	**Kuchkarov Anvarbek Shermirzayevich**, SCIENTIFIC AND PEDAGOGICAL FOUNDATIONS FOR IMPROVING PHYSICAL EDUCATION AND SPORTS PEDAGOGY IN THE CONTEXT OF DIGITAL TRANSFORMATION	**163**
38.	**Ne’matjonov Turg‘unpo‘lat Shokirjon o‘g‘li**, ANALYSIS OF HISTORICAL TOPONYMS IN THE BABURNAMA	**168**
39.	**Mamatov Axadbek**, BUXORO VOHASIDA NAQSHBANDIYLIK TA'LIMOTINING SHAKLLANISH BOSQICHLARI	**171**
40.	**To‘rayeva Charosxon Shavkat qizi**, MAKTABGACHA YOSHDAGI BOLALARNING INTELLEKTUAL RIVOJLANISHIDA MONTESSORI METODIKASINING SAMARADORLIGI	**177**
41.	**Tosheva Kamola Komiljon qizi**, TRAINING LOAD PLANNING FOR HIGHLY SKILLED FEMALE WEIGHTLIFTERS	**183**
42.	**Khamraeva Zamira, Razhabov Rustam, Khovaylo Vladimir**, MAGNETIC PROPERTIES AND ELECTRICAL RESISTIVITY OF FE(NI)-MN-AL MELT-SPUN RIBBONS	**189**
43.	**Sirojev Shoxrux Fayzullo o‘g‘li**, THE ROLE OF VOLLEYBALL IN DEVELOPING PHYSICAL AND PSYCHOLOGICAL READINESS	**191**
44.	**Otabek Turlibekov , Oliy Akhmedov , Avazbek Taniberdiyev**, SYNTHESIS, PROPERTIES AND POTENTIAL APPLICATIONS OF QUATERNARY AMMONIUM DERIVATIVES OF CHITOSAN OBTAINED FROM PLEUROTUS OSTREATUS	**194**
45.	**Курамбаева Дилафруз Шаукатовна**, ОБРАЗ УМАЙ В МИФОЛОГИЧЕСКИХ ПРЕДСТАВЛЕНИЯХ КАРАКАЛПАКОВ	**202**
46.	**Keldibekov Jahongir Vali o'g'li**, XOSMAS INTEGRALLAR KONVERGENTLIGINING YANGI SHARTLARI HAMDA ULARNING DIFFERENSIAL TENGLAMALAR MODELLARIGA TATBIQI	**207**

47.	**Sharipov J.R.**, BILATERAL VERTEBRAL ARTERY HEMODYNAMIC RESPONSE IN ARTERIAL HYPERTENSION COMPLICATED BY ISCHEMIC HEART DISEASE	**212**
48.	**N.B. Saidmurodova , G.U. Lutfullaev**, MICROBIOLOGICAL CHARACTERISTICS OF THE NASAL MUCOSA IN PATIENTS WITH CHRONIC SUBATROPHIC RHINITIS ASSOCIATED WITH TYPE 2 DIABETES MELLITUS	**215**
49.	**Narbayeva Sofiya Murod qizi**, SUN'IY INTELLEKTGA ASOSLANGAN PEDAGOGIK TEXNOLOGIYALAR ORQALI OLIY TA'LIMDA TALABALARNING AKADEMIK MUVAFFAQIYATINI OSHIRISH	**225**
50.	**Sattarova Muhabbat Alijanovna**, DEVELOPING THE CREATIVE POTENTIAL OF STUDENTS IN PEDAGOGY PROGRAMS	**230**
51.	**Sattarova Muhabbat Alijanovna**, MENTORSHIP MODEL FOR WORKING WITH GIFTED STUDENTS	**232**
52.	**Sattarova Muhabbat Alijanovna**, STRUCTURAL COMPONENTS OF AN INNOVATIVE PEDAGOGICAL MODEL	**235**
53.	**Sodiqova Vazira Yaxyoqul qizi**, CURVATURE CORRESPONDING TO A SQUARE: DEFINITION AND GEOMETRIC MEANING	**237**
54.	**Xoldarova Dilfuza Komiljon qizi**, MUAMMOLI TA’LIM ASOSIDA KOGNITIV VA METAKOGNITIV O‘ZLASHTIRISH TEXNOLOGIYALARINING O‘ZIGA XOS JIHATLARI	**240**
55.	**Dusmurodova Muhayyo Faxritdin qizi**, TA’LIM JARAYONIDA SHAXSIYLASHTIRILGAN O‘QITISH ORQALI SHAXS RIVOJLANISHINI TA’MINLASH USULLARI	**247**
56.	**Jumaboyev Azizjon Sayfiddin o‘g’li**, SAMARQAND O‘LKASHUNOSLIK JAMIYATLARI FAOLIYATIDA MADANIY MEROSNI ASRASH MUAMMOLARI (XX ASRNING 20–80-YILLARI)	**253**
57.	**Файзиев М.М.**, МАТЕМАТИК РЕЖАЛАШТИРИШ АСОСИДА МАРКАЗДАН ҚОЧМА КУЧ ТАЪСИРИДА ЮҚОРИ ЭКСПЛУАТАЦИОН ХУСУСИЯТЛАРГА ЭГА БЎЛГАН АНИЗОТРОП СТРУКТУРАЛИ ЦИЛИНДРСИМОН ФИЛЬТРЛАР ОЛИШ ТЕХНОЛОГИЯСИНИНГ ОПТИМАЛ ПАРАМЕТРЛАРИНИ АНИҚЛАШ	**256**
58.	**Бабажанова Навбахор**, “ПСИХОЛОГИЧЕСКАЯ ПРИРОДА ОБРАЗА «ЛИШНЕГО ЧЕЛОВЕКА” В РОМАНЕ И. С. ТУРГЕНЕВА “ДНЕВНИК ЛИШНЕГО ЧЕЛОВЕКА”	**260**
59.	**Абдурахимова Зарнигора Бахтийор кизи, Абдураимова Н.Р.**, РОЛЬ ОБРАЗОВАНИЯ И ПРОФЕССИОНАЛЬНОЙ ПЕРЕПОДГОТОВКИ ЖЕНЩИН В УСЛОВИЯХ РАЗВИТИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА	**262**
60.	**Sultonov Bobirxon Muhammadxonovich**, FUQAROLIK HUQUQIDA MAJBURIYATLARNING BAJARILISHINI TA'MINLASHNING O'ZIGA XOS XUSUSIYATLARI	**267**
61.	**Akramov Ibrohimjon Oxunjon o‘g‘li**, OILAVIY MUNOSABATLARDA TENG HUQUQLILIK PRINSIPI HUQUQIY MAZMUNI	**270**

62.	**М.М. Файзиев**, ПЛАСТМАССА МАҲСУЛОТЛАРИНИ ИШЛАБ ЧИҚАРИШ ЖАРАЁНИДА МОЙДАН ҚАТТИҚ ЗАРРАЧАЛАРНИ АЖРАТИБ ОЛИШ УЧУН ФИЛЬТР ЭЛЕМЕНТЛАРИНИ ОЛИШ ТЕХНОЛОГИЯСИ	**274**
63.	**Turaev Ahmed Kholmominovich**, DIRECTIONS THAT INFLUENCE THE FORMATION OF TESTOLOGICAL COMPETENCE	**277**
64.	**Ixtiyor G‘aniyevich Jalilov**, THE HISTORICAL EXPERIENCE OF THE MAHALLA INSTITUTION AND PUBLIC OVERSIGHT IN SOUTHERN UZBEKISTAN	**280**
65.	**Ixtiyor G‘aniyevich Jalilov**, FACTORS INFLUENCING THE DEVELOPMENT OF FAMILY ENTREPRENEURSHIP IN THE MAHALLAS OF SOUTHERN UZBEKISTAN	**285**
66.	**Yuldashev G‘ulomjon, Qosimov Bekzod Ulug‘bek o‘g‘li**, KARKIDON SUV OMBORI ATROFI TUPROQ PROFILIDA TUZLAR REJIMI VA MIKROELEMENTLARNING RADIAL-LATERAL DIFFERENSIATSIYASI	**289**
67.	**Kamol Akbarov,** KARKIDON SUV OMBORI ATROFI TUPROQ PROFILIDA TUZLAR REJIMI VA MIKROELEMENTLARNING RADIAL-LATERAL DIFFERENSIATSIYASI	**295**
68.	**Jo’rabekova Gulshoda,** KOGNITIV USLUBNING YOSHGA BOG’LIQ XUSUSIYATLARI	**298**
69.	**Sharobiddinova Gulshodaxon Rustamjon qizi,** IKKI O’LCHOVLI SIMPLEKSDAGI ALMASHTIRILGAN VOLTERRA OPERATORLARINING DINAMIKASI HAQIDA	**301**
70.	**Аминова Моҳирахон Мўминжон қизи,** СОЗДАНИЕ ХИМИЧЕСКИХ ПРЕПАРАТОВ ДЛЯ ЗАЩИТЫ СЕЛЬСКОХОЗЯЙСТВЕННЫХ КУЛЬТУР НА ОСНОВЕ ПРОМЫШЛЕННЫХ ОТХОДОВ И ИХ ПРИМЕНЕНИЕ	**304**
71.	**Rakhmanova Nozimakhon Ibrokhimjon qizi,** NATIONAL-CULTURAL UNITS IN ENGLISH AND UZBEK: A CROSS-LEVEL COMPARATIVE ANALYSIS OF THEIR SEMANTIC, LINGUOCULTURAL, AND PRAGMATIC FEATURES ABSTRACT	**307**
72.	**Dehqonova Shahnoza Anvar qizi,** MAKTABGACHA TA’LIM TASHKILOTI RAHBARINING BOSHQARUV KOMPETENSIYASINI RIVOJLANTIRISH: ZAMONAVIY YONDASHUVLAR VA SAMARALI MEXANIZMLAR	**320**
73.	**Feruz Yuldashev,** ENTREPRENEURIAL DEVELOPMENT OF HIGHER EDUCATION INSTITUTIONS IN UZBEKISTAN: COMPARATIVE EVIDENCE FROM PUBLIC AND PRIVATE UNIVERSITIES	**325**
74.	**Nurullayev Mirxon Muhammadovich,** AGENTLI SUN’IY INTELLEKT TIZIMLARIDA AXBOROT OQIMI XAVFSIZLIGIGA TAHDIDLAR TASNIFI VA HIMOYALASH USULLARINING QIYOSIY TAHLILI	**329**
75.	**Soibov Johongir Ergash o`g`li,** HUDUDIY ISHLAB CHIQARISH MAJMUALARINI SAMARALI ENERGIYA BILAN TA'MINLASH SXEMALARINI TANLASH MASALALARI	**335**

76.	**Shukurova Ozoda Odil qizi,** RAQAMLI PLATFORMALARDA XIZMAT KO‘RSATISH SHARTNOMALARINING ELEKTRON SHAKLI VA UNI TASDIQLASH MUAMMOLARI	**337**
77.	**Qosimov Oybek Abdumannon o‘g‘li,** PAST INERSIYALI ENERGIYA TIZIMLARIDA GIBRID SHAMOL-QUYOSH ELEKTR STANSIYALARINING CHASTOTA BARQARORLIGIGA TA’SIRINI BAHOLASH	**341**
78.	**Teshaboyev Rivojiddin Ibrohimjon o‘g‘li,** KUCH TRANSFORMATORLARIDA ENERGIYA ISROFLARI VA ULARNI KAMAYTIRISH USULLARI	**346**
79.	**Ergasheva Zilola Ko‘paysin qizi,** MUSIQIY-DIDAKTIK O‘YINLAR VOSITASIDA MAKTABGACHA YOSHDAGI BOLALARNING MUSIQIY QOBILIYATLARINI RIVOJLANTIRISH METODIKASI	**348**
80.	**To`lqinova Gulsanam Bahtiyor qizi,** TEMIR-BETON KONSTRUKSIYALARNING ZILZILABARDOSHLIGINI OSHIRISHNING ZAMONAVIY, AMALIY USULLARI	**354**
81.	**To‘xtaraliyev Sohibjon Murodjon o‘g‘li, Xolmatov Dilshod Sottorjonovich,** TEXNOLOGIK CHANG XOSSALARINI TAVSIFLASH VA CHANG TOZALASH QURILMASI SINOVLARINI METODIK ASOSLASH	**358**
82.	**G`oziyev Islomjon Ravshanovich, N.N.Umaraliyev,** GAZ GENERATORI REAKSIYA ZONASIDAGI HARORATNI MASOFADAN O‘LCHASH VA MONITORING QILISH TIZIMINI YARATISH	**362**