Imagen que contiene Logotipo

Descripción generada automáticamente![Logotipo, nombre de la empresa

Descripción generada automáticamente](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4REwRXhpZgAATU0AKgAAAAgABAE7AAIAAAAjAAAISodpAAQAAAABAAAIbpydAAEAAABCAAAQ5uocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEdlcm3DoW4gQW5kcsOpcyBEaSBGb256byBDYXR1cmVnbGkAAAAFkAMAAgAAABQAABC8kAQAAgAAABQAABDQkpEAAgAAAAM0OAAAkpIAAgAAAAM0OAAA6hwABwAACAwAAAiwAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAMjAyMDoxMDoyNiAxNjoxMzoyMQAyMDIwOjEwOjI2IDE2OjEzOjIxAAAARwBlAHIAbQDhAG4AIABBAG4AZAByAOkAcwAgAEQAaQAgAEYAbwBuAHoAbwAgAEMAYQB0AHUAcgBlAGcAbABpAAAA/+ELNWh0dHA6Ly9ucy5hZG9iZS5jb20veGFwLzEuMC8APD94cGFja2V0IGJlZ2luPSfvu78nIGlkPSdXNU0wTXBDZWhpSHpyZVN6TlRjemtjOWQnPz4NCjx4OnhtcG1ldGEgeG1sbnM6eD0iYWRvYmU6bnM6bWV0YS8iPjxyZGY6UkRGIHhtbG5zOnJkZj0iaHR0cDovL3d3dy53My5vcmcvMTk5OS8wMi8yMi1yZGYtc3ludGF4LW5zIyI+PHJkZjpEZXNjcmlwdGlvbiByZGY6YWJvdXQ9InV1aWQ6ZmFmNWJkZDUtYmEzZC0xMWRhLWFkMzEtZDMzZDc1MTgyZjFiIiB4bWxuczpkYz0iaHR0cDovL3B1cmwub3JnL2RjL2VsZW1lbnRzLzEuMS8iLz48cmRmOkRlc2NyaXB0aW9uIHJkZjphYm91dD0idXVpZDpmYWY1YmRkNS1iYTNkLTExZGEtYWQzMS1kMzNkNzUxODJmMWIiIHhtbG5zOnhtcD0iaHR0cDovL25zLmFkb2JlLmNvbS94YXAvMS4wLyI+PHhtcDpDcmVhdGVEYXRlPjIwMjAtMTAtMjZUMTY6MTM6MjEuNDc1PC94bXA6Q3JlYXRlRGF0ZT48L3JkZjpEZXNjcmlwdGlvbj48cmRmOkRlc2NyaXB0aW9uIHJkZjphYm91dD0idXVpZDpmYWY1YmRkNS1iYTNkLTExZGEtYWQzMS1kMzNkNzUxODJmMWIiIHhtbG5zOmRjPSJodHRwOi8vcHVybC5vcmcvZGMvZWxlbWVudHMvMS4xLyI+PGRjOmNyZWF0b3I+PHJkZjpTZXEgeG1sbnM6cmRmPSJodHRwOi8vd3d3LnczLm9yZy8xOTk5LzAyLzIyLXJkZi1zeW50YXgtbnMjIj48cmRmOmxpPkdlcm3DoW4gQW5kcsOpcyBEaSBGb256byBDYXR1cmVnbGk8L3JkZjpsaT48L3JkZjpTZXE+DQoJCQk8L2RjOmNyZWF0b3I+PC9yZGY6RGVzY3JpcHRpb24+PC9yZGY6UkRGPjwveDp4bXBtZXRhPg0KICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICA8P3hwYWNrZXQgZW5kPSd3Jz8+/9sAQwAHBQUGBQQHBgUGCAcHCAoRCwoJCQoVDxAMERgVGhkYFRgXGx4nIRsdJR0XGCIuIiUoKSssKxogLzMvKjInKisq/9sAQwEHCAgKCQoUCwsUKhwYHCoqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioq/8AAEQgAqQDaAwEiAAIRAQMRAf/EAB8AAAEFAQEBAQEBAAAAAAAAAAABAgMEBQYHCAkKC//EALUQAAIBAwMCBAMFBQQEAAABfQECAwAEEQUSITFBBhNRYQcicRQygZGhCCNCscEVUtHwJDNicoIJChYXGBkaJSYnKCkqNDU2Nzg5OkNERUZHSElKU1RVVldYWVpjZGVmZ2hpanN0dXZ3eHl6g4SFhoeIiYqSk5SVlpeYmZqio6Slpqeoqaqys7S1tre4ubrCw8TFxsfIycrS09TV1tfY2drh4uPk5ebn6Onq8fLz9PX29/j5+v/EAB8BAAMBAQEBAQEBAQEAAAAAAAABAgMEBQYHCAkKC//EALURAAIBAgQEAwQHBQQEAAECdwABAgMRBAUhMQYSQVEHYXETIjKBCBRCkaGxwQkjM1LwFWJy0QoWJDThJfEXGBkaJicoKSo1Njc4OTpDREVGR0hJSlNUVVZXWFlaY2RlZmdoaWpzdHV2d3h5eoKDhIWGh4iJipKTlJWWl5iZmqKjpKWmp6ipqrKztLW2t7i5usLDxMXGx8jJytLT1NXW19jZ2uLj5OXm5+jp6vLz9PX29/j5+v/aAAwDAQACEQMRAD8A+kcUYoooAMUYoooAMUhFLSMQBknA9TQBk6Kwe61bplb0j/xxK18Vx/g3UrW71rxAkE7O32zeAzHBXaBkfiD+ldhW1eDhOz8vyOXCVFUpKS8/zDFGKKKxOoMUYoooAMUYoooAMUYoooAMUYoooAMUYoooAMUYoooAMUYoooAMUYoooAMUYoooAKKKKACiiigBk0yW8Ek0pwkalmOOwrwrxb4yvtd1SZILmSOwVysUSEqGX1b1Jr3cjKkHkV4vrHjbULPW721gtNOEcM7oubUE4BIr2cpjepJqN36nzufStSinPlT7K9/xRx0NxLbyiS3leJ16NGxUj8RXrvw58YyavC2manM0t5HzG5HLp7n1FcP/AMJ/qv8Az6ab/wCAgrvvhxrU2u295Nd29rHJC4VWghCcEZr08yUnQbqU1p1v/wAA8bJ3GOKjGlUevS2j/E7eiiivkz7sKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiori4itbd57iRY4o1LMzHAAFeR+LviRdalI9pocj21p0MynDyf4CuvC4SpiZWh95wY3MKODjeo9ei6npV94l0yxu47Np/Ou5TtS3gG9yfcDp9TiuP8VHwVo10zXmmi6v5m3yRRucgnkljnArBtpP8AhCvC63rANreqLmIvy0EXr9T/AJ6VxMssk0rSzO0kjnLMxySfUmvbwmXLn5oyfL91/wDgHzWPzaTgoyguZ66q/L9/U7NNe8FGRQ/hmVVJ5IlzgfTNd9pV54b0PQzqWjxlbCZg0skILbPdh1GK8MrZ8NeIp/D9+HXMlrJ8txAT8si9+PWuvFZf7SHuN+l3r95wYLNXSqXnFeqS0+7oe9WOpWepW4msLmO4jP8AFG2atCvD9ein8Ka1DqXhu7kisb5fOgKH5R6oR0Irv/Bnjy38QqLO92waiB93Pyy+6/4V4FfAShT9rT1j+K9T6nC5rCpV9hWXLP8AB+h2NFFFeae0FFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUHgUVzfjrXToXhiaSJgtxP+6h9iep/AZNaU6cqk1CO7Ma1WNGnKpLZHAfEfxe+qXzaTYSEWcDYlZT/rXH9BXOeFNL/tjxNZWjD93v3y+yLyf5Y/Gsnr165rr/AAPizsdd1X+K2syiH0Zv/wBVfaOksLhuSnvt83ofnMa0sbjFUq7b/Ja2MjxXq51rxJc3I/1KN5UI7BF4H59fxrGoJycnrSV204KnBQXQ8+rUlUm5y3YUtJRVmZ2Okf8AE8+H+padKd02mn7Vbk9Qv8Q+nWuSgnltp0mt3aOSNgyupwQRXSfD25EPi2K3f/VXkTwOD3yP/rVz99bGy1C4tW4MMrRn8DiuOklGtOm9nr9+531m5UKdXqrr7tV+DPcPBHikeJdH3TYW8gwk6jv6MPY101fPvhDXT4f8RwXRYiBj5cw9VP8Ah1/CvoFWDqGUgqRkEd6+WzLCrD1vd+F7H2+T454uhafxR0f+YtFFFeYe0FFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABXjvxX1Q3PiKGwRv3dpFlh/tt/9bFexV88+Lbs33i7Upycgzsq/ReB/Kvayanz13J9EfOcQ1nDCqC+0/yMiuusP9E+FOpS8g3d6kWfYYP9DXIV199+6+E+mJ/z2vXc++Nwr6PFa8ke8l/mfIYPT2ku0X/l+pyNJS0ldhwhRRRSA0vDs5tvEunSg423KZ+mcVc8bQfZ/GmpLjG6Xf8AmAf61jW0nk3UUgONjhvyNdL8R02+NJnHSWGN/wDx3H9K5JaYmPmn+aO+GuDl5SX4pnK1794G1L+1PB9lMTl0Xyn+q8V4DXq/wfui2m6hak/6uVXA+ox/SuDOKfNh+bsz0uH6vJi+T+Zf8E9Hooor5E+/CiiigAooooAKKKKACiiigAooooAKKKKACiiigAPQ4r5wurDUJLyZ2srolpGJPktzk/SvbvGeuX/h/Rhf6fDFKFkCyCXPAPcY968//wCFt6v/AM+Nn+Tf4172VqvTjKdOKafnbY+WzuWFqTjSrTcWtdr7nF/2bff8+N1/35b/AArrddtLn/hXvh+BLaZmDSMyiNiRz344qf8A4W3q/wDz42f5N/jW7rHj/UNP8OaRqEVtbtLfKxdWBwuPTmvQrVMU5wvTW+mvkzyKFHBKFTlqvbX3fNeZ5f8A2bff8+Vz/wB+W/wpP7Nvv+fK5/78t/hXqFp4p8aX2kHUrXRbV7fG5eoZh6gZ5rFi+K2uTTpDFp9q8rttVArZJ9OtaxxWJlflgtN/eMZ4LCQs5VJK+3u7/icT/Zt9/wA+Vz/35b/Cj+zb7/nyuf8Avy3+Fen6v4t8Y6HYpd6hpFmkLYBZSTtJ6A88VR0n4heJtbvhaabplpLLjceoCj1JzxSjjMRKPOoxt/iHLA4WM1Tc5cz6cv8AwTz7+zb/ALWVznt+5b/Cur+INjdXGt2c8VrPJ5lhFuKxMcHng4HWtjWPiB4n0K7+zanplpE5GVIyQw9Qc81d8TfEDUNFOnC3trd/tVos7b88E9hWLr4mdWE1Bdba7nRHD4OFGpB1Ho1f3dt/M8w/s2//AOfG6/78N/hXoXwlgubbUtRW4t5oleJMGSMrnBPr9aof8Lb1f/nys/yb/GrFj8UNbvtQgtYrKz3zSKi8N3P1q8T9brUZQcEk/MnB/UcPiI1Y1G2unL/wT1mikXO0buuOcUtfIH34UUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUARXMMdxbvFMiyIykMrDINfNMo2zOBwNxxX004ypx6V4DL4N8RGZyNIuSCxwdor6DJqkIc6m7bfqfKcRUZ1PZuEW99l6GDXX+Jv8AkR/DP/XOT+YrL/4QzxF/0CLn/vkV0/iDw5rFz4Q8P28GnzPNbo4lQLymSMZr2K1ak6lO0lv38mfP4fDV1Sqpwey6Puj0zSUWPQrJUACiBMAf7orxzw/Gg+Kka7RtF7JgY4GN1djbeJvFlvZxQDwnIwjQJu3nnAxXJWOk+JrLxQuspoM7sJml8o9Oc8Z/GvIwlN01V5pL3lpqj3sfWVZ0OSL91q/uvy8j1Dxuqv4K1QMAcQEjPqK4z4PKPM1RyBuxGAe+PmqzrGu+K9X0e5sG8LSRi4jKFwxO38KyPCSeJ/ChufK8OzXH2jbndxtxn/GopUXHBzpNq7a6ryLr14zzCnXUXypa+6/PyND4wIPL0x8fNucZ9sCue8ffe0P/ALBkdafiweJvFcdssvh2a3+zliNpznP/AOql8aeGtYvW0j7Jp803k2CRybQDtYdRXZhZRpRpRnJXXN1Rw46Mq8q86cXZ8vRnn1d98JLeKXXrySSNWeOAFCRnbk84rnP+EN8Rf9Ai5/75Fdv8MdC1PSdVvZNSspbZHhCqZBjJzXVj61N4WajJX9ThyvD1VjabnB2v2fY9LFFA6UV8WfowUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFRXMJuLeSJZZIS64EkZAZfcZzzXgWh+J/FV/8AFFfDdz4jvPsq3skLMoQMyoW/2epxXTRw7rRk09tTnrV1ScU1ufQVBry/4vXut+HtLs9S0HV72GSe4W3aBdrKfkJyBjOflqD4TfEiXxJbyaHr90f7TUFoZzhTMvp/vD+VX9Um6Pto6ol4mKq+yejPVsilrzjQf7Yb4r6ppNzr99cWFhbxzRxSFMuX7MQvIHtiuJ8Y+JvE2ifE1tBsvEV6LR5oVUsELKJMZ/h7Zp08I6k+RS1tcU8UoR5mutj32ivLvGemeNPDGhy6zoniu6vVtRvmguIYydncjjt6elQ+FviBdeOfB2pwS3T6brWnwGbzbXAEgCnDYIPGRyKn6rJw9pFpof1mKnySVmer0YFeHfCLxJ4i8V+KJYtY127kgtYfOEShAHO4DDcdOa6rxxJrNr468PWuna5eWlrq0zRTRJsIXaAflyvGfxpzwkoVfZN67hDEqdP2iWh6PRXimq+PbzWfiSPDaa5Joek20jQSXK7RJK69SWI4yRit/VfC3iy21TTV8P8Ai7U5rC8lK3EkoSQwLtLBgcDIOMfXFOWEcLc8rXVxRxKlfkjex6ZRXh/xMvvFPgRNONp4svrs3ZkDeZGi7duPQe9bFpY+MbvwPp3iCw8UX91czLFM9n5KEMpYbgCBnpR9UtBT5lZ7biWJvJw5Xdeh6xmivn/4ieK/E/hjxw+mad4gvBbMkcgVwhK7uoztrY+IV54u8BQ2Go2Xim4vYLh9hjuIY+GxnsORVrAyfL7y97bcn65Fc10/d3PaKK47wvrtz44+HSag0kunXTqytLbEAh1OMrkHg46V5v8AC7xV4l8U+NFsdW167e3hhaYogQbypAweOnNZwwk5Rm27cu5pLExTiv5tj3misLxlry+HPCd7qHWZU8uBe7SNwo/MivI/hn441+L4iHRvE+oT3CzB4DHO2fLlByMfkR+NTSws6tOVRdB1MTCnNQfU95orlviJJeWngu+1HTNQuLG5s4jKhhIw/swIPFcL8Hde13xXqV9LrWtXU6WQQpD8oVy2fvcZ7UQw7nRdW+iHKuo1VTtqz2OisvxLcy2nhfUZ7aQxyx27MjjqpA61jaXoN9faTa3UviLUleaJXIDJgEjP92ohSThzydlsKpXlGp7OMbu1zraK5LXp73wx4d22+oS3FxdXCQpcXWD5W7jPAA4p7+E737L5lv4i1H7btysjyAoT7rjGKr2Mbczlo9jN4mfNyRhdrV6r+mdVRWZ4fub660WF9WgMF4MrKpGMkHGR7HrWnWEouMnFnXCSnFSXUK+bvC//ACcI3/YTuf8A2evo24WV7d1t3WOUj5HZdwU+pGRmvMNP+Dlzp3ipfEEPiNmvVnaclrQbWZid2Ru75Nd+Dq06caim7XVjjxVOdScHFbO5tfEjBm8KBun9uwZz9GrzD4o+CrnwZ4ij8SaDujs5ZxIpQf8AHvLnOPoe35V614x8G3viubTymsfYUsJluI1S33EyjoxJPT2rdudKTVNCfTdc8u7WaMpMQm1W9wMnH506OJVBQs773RNXDus5XVtrM8y+FfiQ+K/H2r6s8XlTSadAsqjpvBIJHtxmuP8AiT/yXaP/AK72n8lr1HwF8M18Dapf3UOom6W6jEao0W3YASRznnrWXrvweuPEHiaTXLrxC0d2zqy+XagBNuNuPm7YFdFPEUIYiU07RtZGM6FaVCMWtb3Ox8dXcFl4D1ia5cIn2R1yT1JGAPxJrxL4NaXdXE2v30UbGGPTZINwHDO3IX/x39RXpWr/AAz1LxMYovEvi27u7SMg/Z4YEiVj6nHeuw0Pw/pvhzSk0/SLZYLdeoHJY9yT3JrnhiKdChKnF3bNpUZ1aynJWSPEP2fyF8XagpIDGz4B6n5xXovjU+b8Q/BMCcyC7mk2/wCyI+TWZffB02/iZta8Ja5Lo0zsW2CPeEJ6heRwfQ10Xh3wTLputNrev6tNrOq7DHHLIoVIUPUIo6ZrXEV6U6vt0+m3ysRRpVIU/ZNdd/mch40+Etr4uu59d8LahCs87t5sbcxSODhiCOhyDn3rmfhLr+uaL4+XwtfSSvbu0kclu7bvJdVJyvoOMfjXpX/CG+ItN1C/k8NeJUtLS9nac2s9oJBEzHJ2nPHJqbwf8ObPwxqFxqtzdSajq1ySZLqVQMZ67R2zQsVFUJU6kuZW07oTw8vbKcFbXXscN+0P/q9C+s3/ALJXo3w7/wCScaF/15p/Ksfx58NpvHV9BJc6z9mt7YERQpb5wTjJJ3c9K6LwnoVz4b8PwaVcXwvUtl2QyeVsITsDyc1jVq03hIU09UbU6c44mU2tGeE/Gj/kqh/64Q0vxH1XVP8AhOrXT/GRNxpdq4eJLdfL8yJurD/awMfhXoXif4QTeKvEUmr3+vbJmChUjtQFVV6D71bfi74eR+MtDtLbU7xUv7U5W8igAyO4256HjvXbDGUYqmm9lZ+XoccsLVk5tdXf1N7R4tMh8K266Csa6f8AZ8wCPptIz+deEfAr/kok3/XlJ/6EtereF/A2q+FdBuNKsvECywSA+UZrXJhJ6kfN09qyfCPwjm8H6+mqWGvea+wxuklsMOpxkfe46da56dWlTp1Yc1+bbc6KlOpOdOXLtuN+IN9c6x440bQNM0+TUhp5Go3dukioHwcIpJ49T+IrzH4jf2npfj6LXpNKk0ee4ZbiNGlWTLpjJyvHUD869u0LwZe6T4w1DX7jV1u5NQG2WM2+3aB90Kd3AHH5VX8ffDxvHT2gm1JbSK1yUCwbmJPXnPTgcYqsPiaVKpGL+G2r167kV8PUqxcut9Ng8W6pHrXwav8AUocbLnT/ADBjtnGRXDfs9f8AHxrn+7F/7NXZW/w71G28ByeFU19TaSEjzGtcsqE5Kj5vX+dUPDfwp1PwnJcPofip4DcACTdZq+cdOp96mNSjHD1KSlu9NypQqutCo47LU6/xbcQt4X1e3WVDMlozNGD8yqc4JHocH8qoaJoN5LoNjIniDUIlaBCEXy8Lx0GVpNO8FXMFjrKaprMmo3erKEe5eILsUAgAAdhk1Yt9A120to7eDxFtjiUIo+xocAVhGcY0+SMlv1Xl6Cq05Sre0lBtWto7dfVFi9tNPi02HSdfupL1b2Ty42uByzdQMqAB7VS/4RK/0+P/AIkOv3cG0fLDcYlj+nPIFXJ/Dk2paTJaa3qDXUm8SQzxxiNoWHQjHeq40fxOsPkDxDEUxgSm1HmY+ucZojOysprzutPloTUp3d5U3to09V6u5Z8Ka1cavZXCahGkd5ZztBN5f3WI7j863qztE0aDQ7D7Nbs0hZjJLK5y0jnqxrRrlquDm3DY78PGpGlFVHqMllWGFpH3FVGTtUsfyHJrDj8baHKGMU8zhDtbbayHafQ/LW/XAeFb+5sv7eW30ya8A1KY7o2UAHA45IrWjSjOEm91brY58VXnSqQino79G9vQ6aTxXpMQiJnkbzohKnlwO+VPQ8Dj8arp440GSNpI7mVkQ4ZltpCF+p21p2MMX2OO4W3WGSSFdygYxxnH6mua+H0ST6FqMcqhke+mVge4JqlTpOEpWeluvf5ESq1/aQgmveTe3a3mb934i0+zlWJ3lllZN/lwQtIwX1IUcfjSS+JdLh0ldTedvsbEjzBEx24ODkYyORjmubvjq/hTxFe6lbaedQ0y7CGXyz88O0Y/KpdZv9P1P4Z6jd6Sf3EqMxGMFWLZYEduTVrDwbi1qm1r6/kZvGTSmnpKKbs122a7o3m8TaYmkjU2klFmT/rfIfGPXp09+lXNP1G31WzW6si7Qt91mQru9xkdK5i//wCSQt/2DV/9BFbfhb/kU9L/AOvWP/0EVlUpRjTcl3aN6Vacqqg9uVP5kj6mV8Rx6Z5Yw9sZzJn0YDGPxqbUtUtdIszdX7MkKn5nVGYL9cDisuX/AJKFB/2Dn/8AQxUnjP8A5E3U/wDrgaSpxc4R72G6s40qk+sb2+SL9jqtrqVh9ssy7wYyG8phuHsCMn8Kr2XiTTdQW4Nm80n2bPm4t3G0+nTr7daj8Jf8ifpX/Xqn8qreFgPO13Ax/wATOT/0FaHTgufy/wAxxq1Gqb/mWv3XHx+NdCljaRbqTy0ba8hgcKp9CcYFWr/xLpWm2cV3dXOLaUZSZEZ0P4gECuP8KXsVvoWswNby3Ms19cBIY4y2/oMZ6D8TUkOhzab8PbTTtVUFp7yPfFnOwNIPl/KumWGpRnZ33t6o4YY2vKnzKz0b9Hfb5nd2t3Be2kdzauJIZVDIw7g1QTxLpcusPpcVwZLxDh40jZtv1IGBXMeF9VbQdJ1jSr4kyaQ7eSD1ZG+4B+P8xVfwrYyab8RLmCc7pm09ZJm/vOxBY/man6rFc93stPP+rmn16cvZKK1k7Py/ppnolFJRXnnri0UmaM0ALRSZozQAtFJmjNAC0UmaXNABRRRQAyVnWJjGm9wPlXOMn61yOgaf4g0U6hvsLWb7XdPcAi527d3Y/Lz0rsaK1hVcIuNtznq0FUnGd2mtvmZ1mdSTS3e9jSS8YswiR8KATwoOOwxzWV4O0rUdFt7q31CCJVlnedZI5d33j90jH6101IaPavlcbbh7Bc8Ztu8f1MN5tftZ7iGOwivYncmGY3ATap7MCM8e1Zc/ha9t/BFzpFmIprm8dnlbfsRGY5446DGK7GirjXlG1kuj+4ieFhO/M29GvRPc5a50vVJvAf8AY62sIuWtxbk+d8oAGN2cfpWt4ftrqy0K0tL2NI5beJYzsfcGwMZrToNTKs5R5WutyoYeMJqabva3yOfl/wCShwf9g5//AEMVr6hZR6jp89nP/q50KN9CKyJP+ShQf9g9v/QxXQCnUbTi12QqMVJTT2bZyGj2/ibQdPTSlsre/hh+WC68/ZhewZSM8e1bWladLpOkyJhbi7kdppSDtDyMcn6DtWpRROs59Frv5hTw0aaSTbtor9P68zmPB+lanoq3kF/bxBLm5e4Ekcu7bux8uMVc8TWl/fWtvFp0EcjJOkzGSTaPlYHHQ9a26WiVaTqe0a1COGjGj7FN2/E5XUPC0uoeKrDVuIIwgF5CHzvKnKD35/kKIdJ1VPH02stbxC1kgFvtE3zAA/exj9K6qin9Yna3lb5E/U6XNzLvzfMKMUUVznYGKMUUUAGKMUUUAGKMUUUAGKKKKACiiigD/9k=)

UNIVERSIDAD POLITÉCNICA DE MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INDUSTRIALES

MÁSTER EN AUTOMÁTICA Y ROBÓTICA

DISEÑO Y CONTROL DE ROBOTS – PEC 2

DISEÑO, DESARROLLO Y CONTROL DE UNA PLATAFORMA ROBOTIZADA MÓVIL PARA EL ROBOT MANIPULADOR IRB 1520ID DE ABB

Autores:

Germán Andrés Di Fonzo Caturegli

Juan José Jurado Camino

Tutor:

Roque Jacinto Saltaren Pazmiño

Madrid, 25 de octubre de 2020

Tabla de contenido

[1 Introducción y Objetivos 3](#_Toc55402469)

[2 Diseño de la plataforma robotizada móvil 4](#_Toc55402470)

[2.1 Descripción general 4](#_Toc55402471)

[2.2 Chasis 5](#_Toc55402472)

[2.3 Tablones de Aluminio 6](#_Toc55402473)

[2.4 Ruedas Directrices 7](#_Toc55402474)

[2.5 Ruedas Motrices 9](#_Toc55402475)

[2.6 Motores de la Plataforma 13](#_Toc55402476)

[2.7 Sistema de alimentación 15](#_Toc55402477)

[3 Modelado en Simscape de la plataforma 16](#_Toc55402478)

[4 Robot IRB 1520ID de ABB 19](#_Toc55402479)

[4.1 Características generales del robot IRB 1520ID 19](#_Toc55402480)

[4.2 Modelo en Simscape del robot IRB 1520ID 19](#_Toc55402481)

[4.3 Simulación del robot IRB 1520ID encima de la plataforma 19](#_Toc55402482)

[5 Observaciones y conclusiones 19](#_Toc55402483)

# Introducción y Objetivos

El objetivo general que se busca con este proyecto es el de diseñar y controlar una plataforma robotizada móvil para que se coloque encima suya el robot antropomórfico IRB 1520ID de ABB. También se pretende calcular las características de los motores necesarios para mover las articulaciones de este robot antropomórfico e implementar un control sobre el mismo.

Este proyecto estará dividido en tres partes (pruebas de evaluación continua – PECs -), de manera que cada parte se corresponda con un informe en el que se irán mostrando los avances progresivos del diseño y el control de la plataforma robotizada y el control del robot antropomórfico.

Este informe se corresponde con la primera prueba de evaluación continua (PEC 1) y los objetivos específicos que se pretenden alcanzar son los que se enumeran a continuación:

1. Diseño del chasis de la plataforma robotizada móvil mediante el software Inventor Professional de Autodesk.
2. Cálculo y elección de los motores necesarios para mover la plataforma robotizada móvil.
3. Elección de las baterías para suministrar energía eléctrica a los diferentes motores del sistema robotizado.
4. Modelado y simulación de la plataforma robotizada móvil empleando la herramienta Simscape de Simulink (Matlab).
5. Modelo de la dinámica inversa del robot manipulador IRB 1520ID para determinar sus curvas de respuesta y poder calcular los motores necesarios de sus tres primeras articulaciones.

# Modelado dinámico

## Descripción general

La descripción de comportamiento dinámico para cualquier robot de grados de libertad viene caracterizado mediante la siguiente Ecuación de dinámica:

Donde:

* es la matriz de inercia. La matriz de inercia es una matriz simétrica definida positiva de .
* corresponde a la matriz centrífuga y de Coriolis. La matriz centrífuga y de Coriolis es una matriz y está fuertemente relacionada con la estabilidad del sistema robotizado.
* es el vector de gravedad. Expresa la dependencia del sistema con la fuerza de la gravedad en aquellos robots que no han sido diseñados con compensación de pares de gravedad. La compensación de la gravedad consiste en atribuir de contrapesos o resortes al robot con el objetivo de independizar el movimiento de la fuerza de la gravedad.

En el caso de los robots provistos únicamente de articulaciones rotacionales, existe una constante tal que:

De esta forma la puede acotarse inferiormente:

## Modelo dinámico del Robot IRB 1520ID de ABB

El robot manipulador IRB 1520ID presentado en este trabajo tiene 6 grados de libertad, sin embargo, el objetivo de este reto es el control de dos de sus articulaciones, por lo que es equivalente a estudiar un robot manipulador de 2 grados de libertad. Para poder aplicar este razonamiento es necesario ensamblar aquellos eslabones unidos a las articulaciones que no se van a controlar [FIGURA]. Se propone realizar el control de las articulaciones 2 y 3.

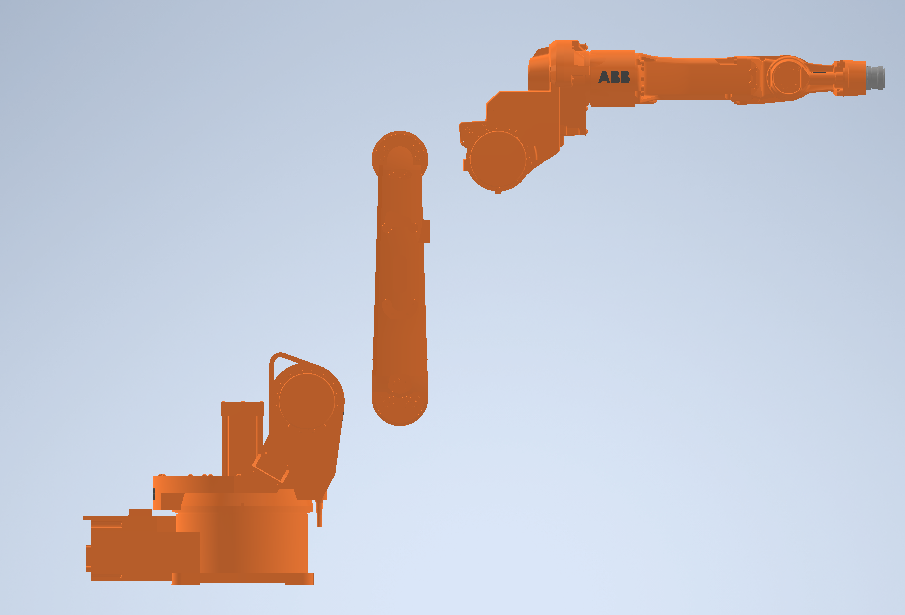


Figura 1 Simplificación del robot de ABB IRB 1520ID a dos grados de libertad.

Eslabón 1 (izquierda inferior), eslabón 2 (medio) y eslabón 3 (derecha superior)

Tras la simplificación del sistema, la ecuación de la dinámica del robot obtenida por medio de Lagrange queda descrita de la siguiente forma:

Donde las expresiones de los diferentes componentes de las matrices son:

Una vez simplificado el robot a tres eslabones se han agrupado todas las características para poder crear el modelo dinámico anteriormente explicado. Las siguientes Figuras muestran el proceso adoptado en Inventor para la obtención de los parámetros necesarios.

Figura 2 Características físicas obtenidas de Inventor de los eslabones 2 (izquierda) y 3 (derecha).

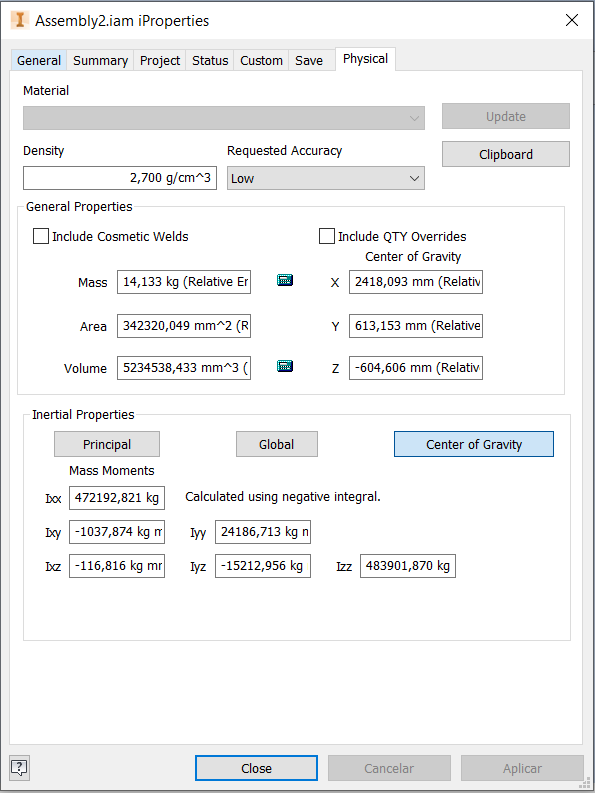
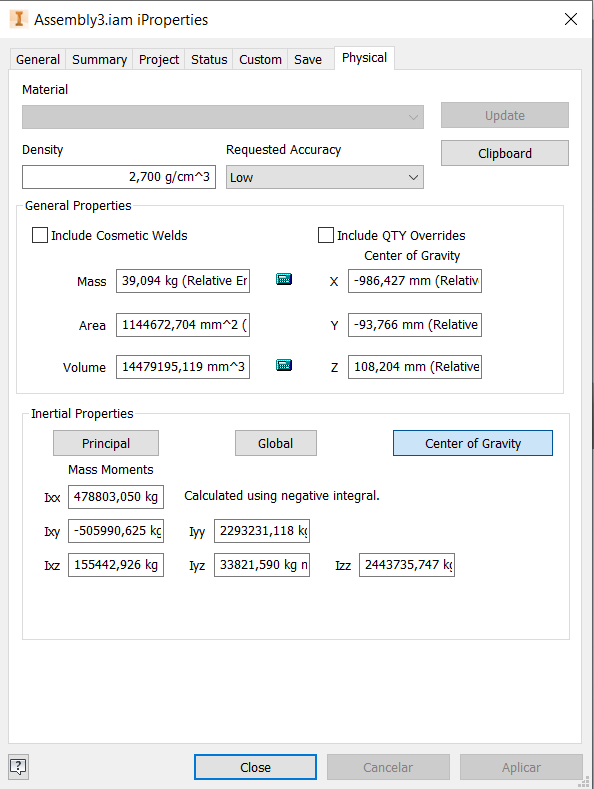


Figura 4 Características longitudinales del eslabón 3.

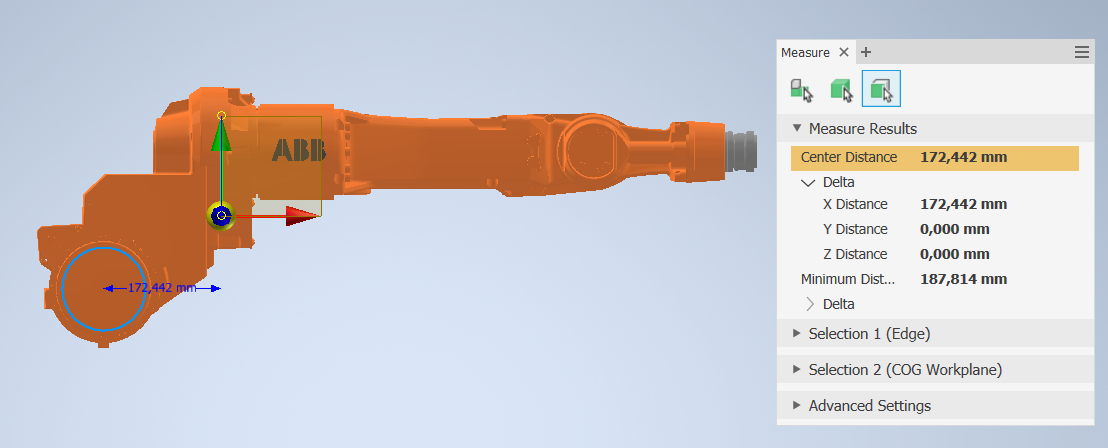
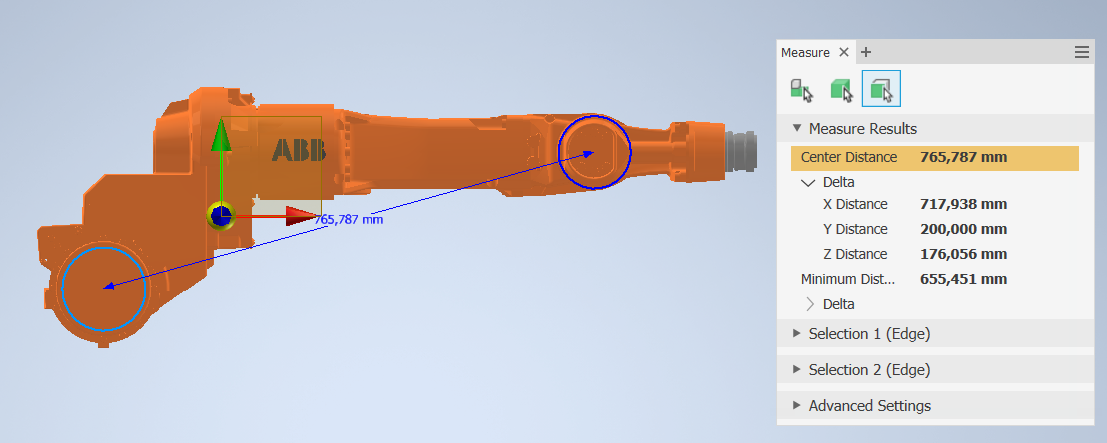
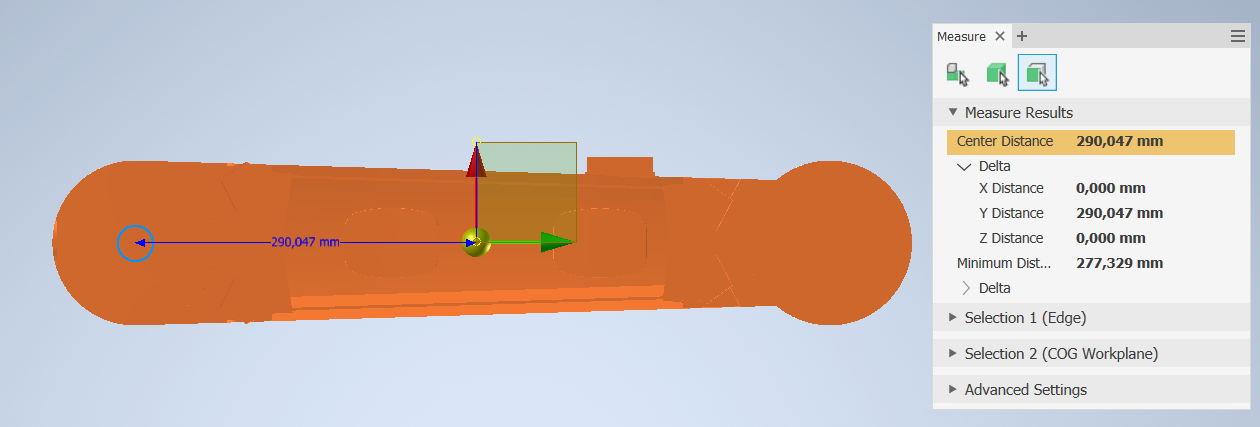
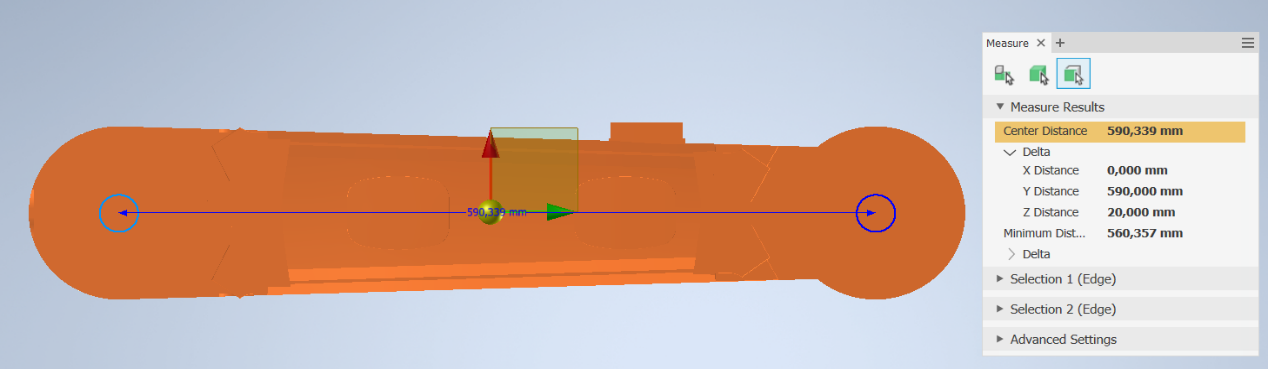


Figura 3 Características longitudinales del eslabón 2.

Una vez determinados los parámetros que definen físicamente al sistema, se resumen en la siguiente Tabla.

Tabla 1 Parámetros físicos del robot de ABB IRB 1520ID

|  |  |  |
| --- | --- | --- |
| **Descripción** | **Notación** | **Valor** |
| Longitud eslabón 2 |  |  |
| Longitud eslabón 3 |  |  |
| Distancia al centro de masa (eslabón 2) |  |  |
| Distancia al centro de masa (eslabón 3) |  |  |
| Masa eslabón 2 |  |  |
| Masa eslabón 3 |  |  |
| Inercia eslabón 2 respecto al centro de masa |  |  |
| Inercia eslabón 3 respecto al centro de masa |  |  |
| Aceleración de la gravedad |  |  |

Una vez determinados los parámetros se procede al cálculo de la

Donde:

# Control del robot IRB 1520ID de ABB

## Control de posición

El control PD es capaz de satisfacer el control de posición en el caso de robots modelados sin término gravitacional (. En estos casos el proceso de diseño del controlador de posición es sencillo, sin embargo, para cuando no es así, como en el caso actual, el objetivo no puede lograrse mediante el control PD. Por este motivo, se explica la elección del PID como controlador para las articulaciones escogidas.

## Diseño del controlador de posición

## Control de movimiento

## Diseño del controlador de movimiento

# Observaciones y conclusiones